Essays on Aging Americans' Travel Preferences: Behavioral Survey Analyses

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ABSTRACT

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The baby boomer generation began turning sixty-five in 2011. Twenty percent of the U.S. population will be over age sixty-five by 2030. Such a rapidly aging population has posed significant challenges to transportation planning and operating agencies since this large number of aging boomers demand dependable transportation access so they can remain independent and age in place. It is crucial to understand, in a timely manner, aging Americans' travel mode choices, their preferences and perspectives on transportation supports, and communication channels through which they prefer to receive information on existing and new transportation options. My dissertation presents three essays to explore these important and urgent issues.

Essay One uses the 2009 National Household Travel Survey (NHTS) data to investigate whether the predominant travel preference—favoring private automobiles—hold for different groups of aging Americans. The analyses not only include the commonly used travel mode choice factors, such as socio-demographics, built environment, and transportation attributes; but also include behavioral aspects such as attitudes towards safety, congestion, public transit, and walking environment. Results show no evidence that Americans are giving up driving as they age. Therefore, planning as though baby boomers will give up driving private automobiles as they age is not likely to be successful. Results also imply that although it may not be effective for existing seniors, promoting positive attitudes on certain travel options that were otherwise not

preferred by middle-aged boomers (e.g., public transit) could be a useful way to encourage this group of boomers to change their future travel mode choices.

Essay Two discusses the design and implementation of my own survey on senior transportation options. A comprehensive survey questionnaire is constructed to target various user groups of senior transportation services, including seniors, caregivers and their elderly dependents, and younger individuals. All these respondents represent current or future customers of senior transportation services. The survey is then successfully implemented via the Amazon Mechanical Turk (MTurk) crowdsourcing platform. Survey data collected from the MTurk platform represents a fairly diversified population; it can capture respondents from different socio-demographic categories, and it shares a similar distribution pattern with the general population data (e.g., U.S. Census) and the large-scale nationwide transportation survey using random sampling method (e.g., NHTS).

Essay Three analyzes my MTurk survey data and investigates the impact of behavioral factors derived from the Theory of Planned Behavior (TPB) on travel mode choices among different user groups of senior transportation services. Survey respondents' preferences on types of senior transportation supports, as well as respondents' preferable channels from which they want to receive information about senior transportation options, are also examined. Results show attitude factors (e.g., convenience, preference, and independence) in general are perceived as more important drivers for seniors' mode choices than other aspects of TPB (e.g., social norm, feasibility, and cost). This indicates more attention should be drawn to attitude factors, rather than the traditional concerns such as feasibility and cost, when designing and implementing interventions on senior transportation services.

Compared to the extant literature, this dissertation research reveals a more comprehensive set of the factors that affect aging Americans' travel mode choices. In particular, it highlights the important role of behavioral factors in seniors' travel model choices. This dissertation research also demonstrates that Amazon MTurk can serve as a valuable crowdsourcing platform for planning related surveys, experiments, and data collections, especially when addressing timely issues such as aging Americans' travel needs. It generates useful insights for researchers and practitioners to develop effective policy and service interventions to improve senior's transportation access, and to address transportation challenges along with the rapid population aging process.

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Introduction

Population aging creates various challenges to transportation planning and operating agencies, as well as to private sectors of transportation services. By 2030, twenty percent of the U.S. population will be over age sixty-five. Elderly population demands dependable transportation access so they can remain independent and age in place. To improve seniors' transportation access, it is crucial to understand seniors' travel mode choices, their preferences and perspectives on transportation options, and communication channels through which seniors prefer to receive information on transportation. This dissertation presents three research essays to explore these issues.

While much prior research has used local or regional interviews and surveys to study seniors' travel behavior, limited work has investigated nationwide datasets to gain a full picture of all aging Americans' travel preferences. Using the 2009 National Household Travel Survey (NHTS) data, ***Essay One*** examines factors that affect seniors' travel mode choice and investigates whether the predominant travel preference—favoring private automobiles—hold for different groups of aging Americans. The analyses include commonly used impact factors on travel mode choices, such as socio-demographics, built environment, and transportation attributes. For seniors, however, travel is often beyond the simple description of origins and destinations; it is a symbol of independence and is a critical factor for quality of life. Therefore, behavioral aspects, such as attitudes towards safety, congestion, public transit, and walking environment, can play an important role, in addition to the commonly used factors mentioned above, on senior travel mode choices. These behavioral factors are also considered in the analyses. The overall study results show no evidence that Americans are giving up driving as

they age, but middle-aged boomers (45–64) may be more inclined to adopt non-auto travel options compared to their senior counterparts. Such heterogeneous perspectives on travel mode choice across age groups bear important policy implications. On the one hand, planning as though current baby boomers want to give up auto travel as they age is not likely to be successful. On the other hand, behavioral interventions, such as promoting positive attitudes on certain travel options (e.g., public transit) that were otherwise less preferred by middle-aged boomers, could be a way to encourage this group of boomers to change their future travel mode choice.

The first essay uses the 2009 NHTS, a traditional travel survey that concerns the general travel pattern of overall population, to examine travel mode choice of current seniors and seniors-to-be. To complement Essay One, ***Essay Two*** presents the design of a unique travel *behavioral* survey to collect first-hand data that represent opinions on senior transportation issues from different types of users, including current and future senior consumers of transportation as well as caregivers of seniors. Data collected in Essay Two complement those studied in Essay One by revealing the existing conditions of senior transportation and exploring potential future complications in senior transportation planning. Amazon Mechanical Turk (MTurk) provides a convenient survey platform that allows researchers to collect samples from a diverse population. It has been shown as an effective tool for psychology and marketing research but has seldom been used in the field of transportation. This essay demonstrates how the newly designed senior transportation survey can be conducted through such an innovative crowdsourcing platform. The results show the MTurk survey data indeed follow the general distribution pattern of the representative sample of a population, suggesting MTurk could be a meaningful and low-cost survey distribution channel for planning related researches.

While there is a consensus among transportation practitioners and researchers on the challenges posed by population aging, we know relatively little about how to increase seniors' awareness of available transportation options and how to encourage seniors to use existing and new options. By analyzing the MTurk survey data, ***Essay Three*** explores answers to address these questions. First, the essay investigates behavioral factors related to the most used travel mode for three types of users of senior transportation options (i.e., seniors, caregivers and their elderly dependents, and younger people). These factors include convenience, preference, independence, social norm, feasibility, and cost. They respectively represent three drivers for one's behavioral change in the Theory of Planned Behavior: "attitudes," "subjective norm," and "perceived control." The study results provide strong evidence that behavioral factors can be more important than traditional utility-based factors, such as cost, in determining seniors' travel mode choices. Then, the essay investigates respondents' preferences on the type of supports regarding senior transportation options, including supports from neighbors/community centers, public agencies, private services, or family members/friends. Furthermore, the essay analyzes respondents' preferable channels from which they want to receive information about (new) senior transportation options. The results in this essay deepen our understanding of potential interventions that can be used to educate seniors with existing and new transportation options and to encourage seniors to select more suitable options to meet their individual needs.

In summary, this dissertation research reveals a variety of factors that affect aging Americans' travel mode choice. It advances our understanding of aging population's transportation preferences and needs by studying a more comprehensive set of such factors compared to the extant literature. In particular, both studies of the 2009 NHTS and the self-designed senior transportation survey include behavioral factors in the analysis and show

behavioral factors play crucial roles in seniors' choice of travel modes. Also, the self-designed survey has been successfully implemented on Amazon MTurk, an innovative crowdsourcing platform. Overall, this dissertation research generates insights for researchers and practitioners to develop effective transportation policy interventions and service innovations to improve senior's transportation access and to address transportation challenges along with the progressive population aging process.

Essay One: Understanding Aging Americans' Travel Mode Choices: Analysis of the 2009 National Household Travel Survey

Abstract

Population aging creates various challenges to transportation planning and operating agencies, as well as to private sectors of transportation services. By 2030, twenty percent of the U.S. population will be over age sixty-five. Elderly population demands dependable transportation access so they can remain independent and age in place. To improve seniors' transportation access, understanding their preferences on travel mode choices is crucial. By analyzing the 2009 National Household Travel Survey (NHTS), this study investigates whether the predominant travel preference – favoring private automobiles – hold for different groups of aging Americans. The study also explores factors that affect seniors' travel mode choices. Different socio-demographic, built environment, and transportation attributes are included in the analysis to examine their potential impacts on travelers' mode choices. The results show no evidence that Americans are giving up driving as they age. Thus, I argue that planning as though baby boomers will give up private auto travel as they age is not likely to be successful. Specifically, traditional public transportation options might not suit for aging Americans; and more diversified auto-like transportation options are necessary. In addition, behavioral aspects, such as attitudes towards safety, congestion, public transit, and walking environment, are considered in the analysis. I find that while attitude towards availability of public transit does not seem to change senior population's strong preference towards auto travel, it may affect middle-aged boomers' choices. These results imply promoting positive attitudes on certain travel options

that were otherwise not preferred by middle-aged boomers (e.g., public transit) could be a way to encourage this group of boomers to change their future travel mode choices.

Keywords: Population Aging, Senior Transportation, Travel Behavior, Mode Choice, National Household Travel Survey (NHTS)

1.1. Introduction

The U.S. senior population (sixty-five years and over) is now growing at a fast rate. There were 43.1 million senior Americans in 2012, representing 13 percent of the U.S. population. This percentage is expected to rise to more than 20 percent by 2030 *(Colby and Ortman 2014; Ortman, Velkoff, and Hogan 2014)*. That is, one in every five Americans will be over sixty-five years old by the next two decades. The baby boom cohort, born in the United States between 1946 and 1964, contributes significantly to this fast-growing trend of population aging *(Hogan, Perez, and Bell 2008)*. This rapid aging of the population brings significant social and economic challenges to each and every stakeholder in society. From the perspective of transportation policies and practices, aging Americans need special attention because their transportation ability decreases with the increase of age; and as a result, they will have limited transportation options compared to younger people. For instance, as seniors get older, they will not be able to continue driving because of physiological changes and associated safety concerns. Meanwhile, many aging Americans live in low-density areas where limited transportation alternatives are available except for private auto driving. The decreased capability of driving and yet the heavy dependence on driving in daily lives (e.g., in order to access grocery stores or doctors' offices) makes it challenging for many seniors to maintain their independence and

quality of life as they grow older. Therefore, it is vital to improve seniors' transportation access. The stereotype thinking in transportation planning for senior transportation suggests investing in the traditional public transportation (e.g., bus); this strategy, however, may not be an effective solution due to reasons discussed above. Instead, innovative ideas to support senior transportation are needed not only from the public sector but also from the private service providers.

Before planners and policy makers may provide any appropriate and effective assistance, it is crucial to first understand aging Americans' preferences on travel mode choices. The aging baby boomer generation *differs* from their prior generations in many ways. They are better educated, wealthier, healthier, and more racially and ethnically diverse. They are likely to stay in the labor force longer and to be more active beyond traditional retirement *(WHCOA 2005)*. As a result, aging boomers are likely to have different travel behavior and transportation needs from what was planned for prior generations and other age groups.

Thus, the purpose of this study is to explore aging Americans' travel mode choices and factors that might affect existing seniors' and aging boomers' travel preferences. The 2009 National Household Travel Survey (NHTS) data is utilized to investigate whether aging Americans are still driving *(FHWA 2018)*. Different socio-demographic, built environment, and transportation attributes are included in the analysis to examine their associations with travelers' mode choice. Furthermore, my analysis considers behavioral aspects (e.g., attitudes towards safety, congestion, public transit, and walking environment) that were first introduced in the 2009 NHTS. Detailed research framework, questions, and methods will be elaborated in later sections.

The remainder of this essay is organized as follows. Section 1.2 introduces the research background and reviews relevant literature on senior transportation (reality and preferences). Section 1.3 formalizes the conceptual framework and research questions. Section 1.4 presents the data and specifies analytical methods. Section 1.5 discusses detailed empirical results and their implications for transportation planning for seniors. Section 1.6 summarizes the study and suggests potential directions for future research.

1.2. Background and Literature Review

1.2.1. Aging of Population

The "aging of population," also known as demographic aging or population aging, refers to "shifts in the age distribution (i.e., age structure) of a population toward older ages" *(Gavrilov and Heuveline 2003)*. It is reflected by a rise in the proportion of the population that is elderly, a decline in the proportion of the population composed of children, and an increase in the population's mean and median ages. Studies of aging populations traditionally focus on retirement systems[1] rather than how older people may use conventional infrastructure systems (e.g., transportation). Population aging is expected to be among the most prominent global demographic trends of the twenty-first century, which is a direct outcome of the ongoing global fertility decline and mortality decline at older ages – known as the double aging process *(Gavrilov and Heuveline 2003)*. Population aging can lead to important socio-economic consequences. For instance, it poses a great challenge for the health care system, because as nations age, the prevalence of disability, frailty, and chronic diseases is expected to increase significantly *(Gavrilov and Heuveline 2003)*.

[1] In the U.S., the age for social retirement systems is typically 65 years and older.

Population aging in the United States is closely associated with the post-World War II Baby Boom. The population sixty-five and over has increased from thirty-five million to forty million between 2000 and 2010 (a 14.3% increase) and is expected to rise to fifty-five million in 2020 (a 37.5% increase from the year 2010). By 2030, there will be about 72.1 million senior citizens, almost doubling their number in 2008 *(AoA 2010)*. This brings numerous challenges to many public and private stakeholders, including transportation planning agencies, as well as transportation operating and service providers. For instance, older populations nowadays are increasingly participating in the labor force. More specifically, 16.2% of the sixty-five-and-older population were employed in 2010—22.1% for older men and 13.8% for older women respectively *(West et al. 2014)*. On the one hand, it is the financial insecurity—worries over inadequate retirement savings—that drives more older adults to participate the labor force, especially with the severe economic impact of the 2007–2009 recession. On the other hand, many other factors impact labor force participation rates of older Americans, including greater longevity coupled with better health and fitness, loving what they do and the satisfaction they get from contributing experience, know-how, and institutional knowledge *(Fideler 2014; Census 2014; Belser 2014; Leonesio et al. 2012)*. The increasing labor force participation rate among seniors implies seniors are in great need of more reliable and independent travel choices than their prior generations, and their needs require transportation planners and policy makers to plan and act promptly.

1.2.2. Spatial Distribution of Senior Population

During the twentieth century, especially after the World War II, dispersed and low-density suburban land use patterns proliferated in the U.S. As a result, a majority of the U.S.

households and individuals, including seniors, now reside in low-density areas with limited public transit services. As a "by-product" of such land use patterns, residential areas were segregated from services areas by the "planned" built environment. Indeed, this locational separation of residences and services imposes further barriers for seniors to buy grocery, to visit health care provider, and to join social activities within an easily accessible distance.

In 2009, most seniors lived outside of principal cities. More specifically, about 77.4%of the senior population lives in low-density suburban or rural areas that often have limited public transportation services *(AoA 2010)*. At the same time, senior persons are less likely to change residence than other age groups. From 2008 to 2009, only 3.4% of senior persons moved as opposed to 13.8% of the under-sixty-five population. Most seniors who moved (62.7%) stayed in the same county, and 83.7% remained in the same state. Only 16.3% of the senior movers moved out-of-state *(AoA 2010)*. Although some argue seniors may prefer a different lifestyle, make a different location decision, and thus change their travel preferences, it would actually not be an easy task to relocate seniors to denser areas with better public transportation services. In fact, most older Americans wish to age in place (more on this below). A 2010 AARP survey shows "nearly 90 percent of seniors want to stay in their residence for as long as possible, and 80 percent believe their current residence is where they will always live*" (Barrett 2014; Farber et al. 2011)*.

Aging in place is referred to as "the ability to live in one's own home and community safely, independently, and comfortably, regardless of age, income, or ability level" *(CDC 2017)*. Aging in place brings a variety of benefits to help the older population with successful aging[2], such as life satisfaction, health, and self-esteem *(Kochera, Straight, and Guterbock 2005; Farber*

[2] Successful aging is defined as "the ability to maintain three key behaviors or characteristics: low risk of disease and disease-related disability; high mental and physical function; and active engagement with life" *(Kochera, Straight, and Guterbock 2005)*.

et al. 2011). It is well recognized that communities across the nation are striving to help aging Americans stay healthy, stay connected, and enjoy "aging in place" *(nadtc 2018)*. Transportation is a vital link to all those goals.

1.2.3. Transportation Reality for Senior Population

Since last century, the U.S. transportation policies and practices have heavily promoted highway and auto travel. This trend has been affecting seniors' travel choices in the past, now, and also in the near future. In fact, seniors tend to be as auto-dependent as the rest of the population. Data show over 70 percent of the seniors live in low-density suburban and rural areas, and over 90 percent of the trips made by these seniors are automobile trips; in addition, seniors shift from driving a private car to becoming a car passenger when they get older *(Rosenbloom 2001; X. Pan 2012)*. According to the 2001 National Household Travel Surveys (NHTS), senior (licensed) drivers drove an average of 7,684 annual miles, or over twenty-one miles every day, which indicates many seniors are still on the wheel in their daily life *(Hu and Reuscher 2004)*.

According to a report based on the 2001 NHTS *(Bailey 2004)*, about 21 percent of Americans age sixty-five and older do not drive. More than 50 percent of them, or 3.6 million Americans, stay home on any given day partially because they lack transportation options. The populations in rural communities and sprawling suburbs are more heavily affected compared to those in urban areas. Public transportation trips by older non-drivers totaled an estimated 310 million in 2001; older minority populations account for a significant share of these trips. More livable communities (i.e., dense and mix-used neighborhoods) have higher rates of public transportation use and walking among non-drivers aged sixty-five and over. More than half of

older non-drivers use public transportation occasionally in denser areas, as compared to one in twenty in more spread-out areas. In many places, public transportation is still not a practical option for older people; for frail older persons, paratransit and specialized transportation are the only feasible modes, other than getting a ride from others *(Bailey 2004)*.

1.2.4. Senior Population's Transportation Preferences

In general, seniors make fewer work and school trips, but they make much more trips for shopping, health care, social events, and recreation compared to other age groups *(Collia, Sharp, and Giesbrecht 2003)*. Many older drivers intentionally drive during the off-peak time to avoid congestion, busier intersections, and aggressive drivers *(Holmes et al. 2002)*. Older adults generally have low rates of transit use, and they appear to have even higher objections to using transit compared with their younger counterparts *(Blumenberg et al. 2007)*.

An early study shows elderly and disabled people in rural Virginia value paratransit more than taxis and buses *(Stern 1993)*. Paratransit refers to a flexible form of transit service for mobility-impaired people that provides door-to-door public transport service. Flexibility is perceived as one of the most important factors. It is also found the demand of trips taken by elderly and disabled people is generally price inelastic; in other words, the total number of trips taken is not sensitive to mode availability and characteristics but is more driven by the need to travel.

An American Association of Retired Persons (AARP) interview with non-institutionalized adults over age seventy-five shows an overwhelming preference for the private car as the ideal means of transportation; urban residents use public transportation more; however,

suburban and rural residents are not fully aware of transportation services available to them; public transport was considered unsafe and taxicabs too expensive *(Coughlin 2001)*.

Using data from several post-industrial nations, Alsnih and Hensher found the "young" elderly (aged 65–75 years) and the "old" elderly (over 75 years) have different travel patterns and needs *(Alsnih and Hensher 2003)*. Their study also points out that instead of the traditional fixed-route public transportation, more flexible forms of transport should be investigated regarding technological and operational feasibility.

A study using rural Upper Great Plains states (including North Dakota, South Dakota, Montana, and Wyoming) survey data shows distance and choice of travel modes have no significant impact on the total number of routine or chronic health care trips. The results indicate many health care trips are inelastic to different transportation characteristics, echoing the findings in the Virginal study discussed above *(Stern 1993)*. However, survey respondents claim issues with public transportation, such as inconvenient schedules, infrequent service, and difficulty of matching transit and medical schedules *(Mattson 2011)*.

Based on 2009 NHTS data, my earlier study found when accessing health care services, many seniors were still driving, and they preferred auto travel to public transportation. Increasing density alone might not be a powerful and effective enough strategy to change seniors' travel mode choice, at least not for the current generation. Mode choice of health care trips was inelastic to some transportation attributes, such as travel distance *(X. Pan 2012)*.

In summary, the prior literature suggests a common observation that a great portion of seniors lives in suburban and rural areas, and they value private auto travel and rides from friends and family members more than public transportation. Public transportation and specialized transportation are generally perceived as inconvenient and unreliable, although they

may be the only feasible modes for some seniors. However, many studies reviewed above use location-specific data; and findings in those studies, thus, may not be generalizable to other populations or areas. This essay expands the prior studies by examining a more comprehensive set of factors that affect seniors' travel mode choice, and by using a nationwide dataset to gain a full picture of all aging Americans' travel preferences.

1.3. Conceptual Framework and Research Questions

Figure 1.1 shows the conceptual framework of this research. Motivated by the challenges along with the fast progressing population aging, there are crucial needs to address the associated transportation challenges faced by both public sectors and private service providers. To effectively address these challenges, it is essential to explore factors affecting seniors' travel behavior first. Using the nationwide 2009 NHTS data, I analyze the potential impacts from four categories of factors on aging Americans' mode choices, and these four categories of factors are socio-demographic characteristics, built environment factors, transportation attributes, and behavioral aspects.

For seniors, travel is often beyond the simple scope of transportation from origin to destination; it could be a self-image issue as it determines one's independence of life *(Schwanen and Páez 2010)*. Therefore, the traditional utility maximization theory of travel behavior may not fully explain seniors' mode choices, which generally accounts for travelers' mode choice by external circumstances, such as travel cost or travel time *(National Research Council (US) 2005)*. Instead, I propose a more comprehensive set of factors in four categories, including typical transportation attributes, socio-demographic characteristics, physical built environment factors, and perhaps most interestingly, individual level attitudes towards travel. The variable

selection in each of these four areas follows the prior literature on (travel) behavior, see, e.g., *(Bandura 1986; McLeroy et al. 1988; Sallis and Owen 2008; Winch 2011; King et al. 2002; S. Handy 2005; National Research Council (US) 2005; Thøgersen-Ntoumani 2009; Emond, Tang, and Handy 2009; S. L. Handy, Xing, and Buehler 2010; Xing, Handy, and Mokhtarian 2010; Broache 2012)*. For instance, transportation-related variables such as travel time, household car ownership, and number of drivers in the household are often employed in the traditional utility maximization theory to model travel behavior. In recent decades, built environment variables such as population density, employment density, and land use are increasingly used in the study of people's travel mode choices. Some studies also apply theories from the field of psychology to include behavioral variables, such as attitudes and preferences, to explain travel mode choices. In addition to the variables mentioned above, socio-demographic variables, such as age, gender, household size, income, and employment status, are commonly-used control variables. The detailed list of variables included in my study is presented in Table 1.1 later.

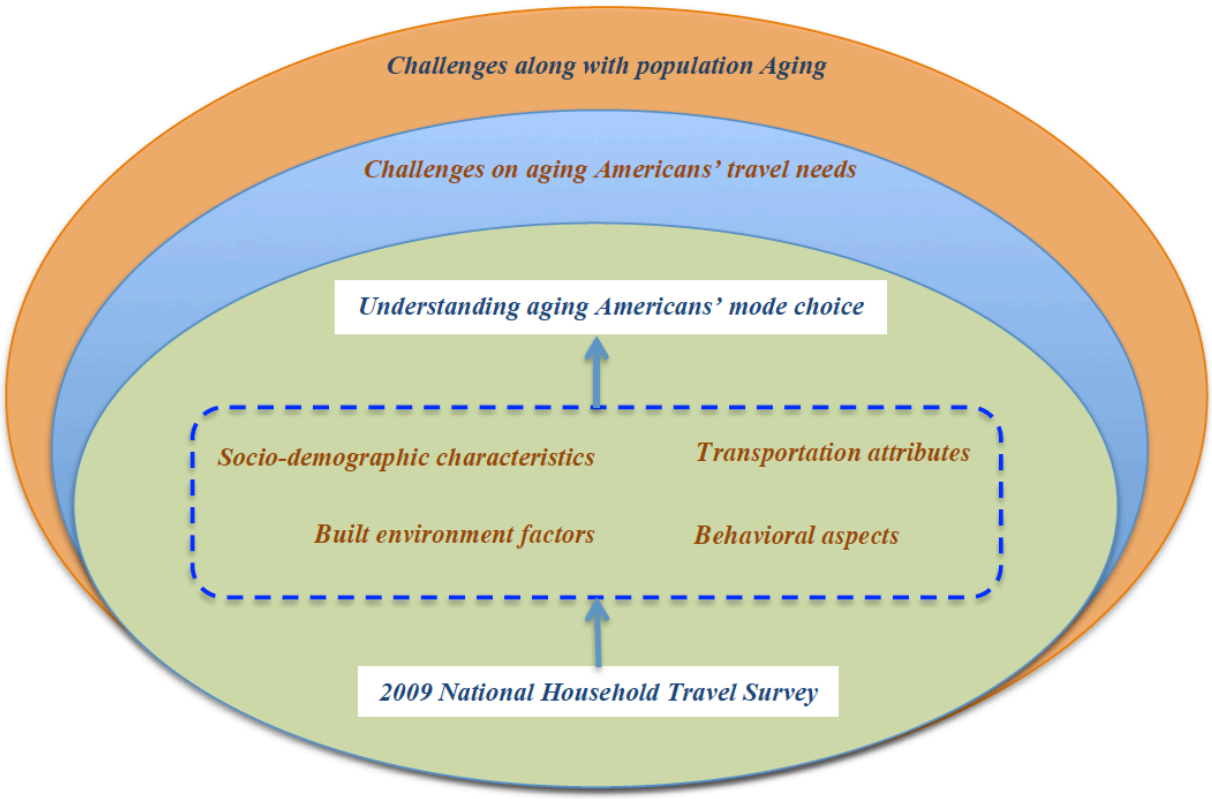


Figure 1.1. Conceptual Framework

This research analyzes travel mode choices for three age groups: seniors (who are sixty-five years and above), middle-aged boomers (whose ages are roughly between forty-five years and sixty-five years old in the 2009 NHTS data), and younger generations (who are younger than forty-five years old). The seniors group represents the existing elderly population; while the middle-aged boomers account for the major contributors of the fast-growing U.S. population aging process in the next several decades. It is important to understand travel mode choices from these different age groups and to identify the similarities and distinctions in travel preferences among them. Distinctions in travel preferences across different age groups, if any, can be particularly helpful for practitioners and policymakers to promptly adjust practice and policies to better meet the transportation needs of aging populations.

As mentioned in the earlier sections, the objective of this research is to explore factors that may affect aging Americans' travel mode choice. Specifically, I examine the following research questions:

1. Does the predominant travel preference—favoring private automobile—hold for aging Americans and younger generations?
2. How are different socio-demographic, built environment, and transportation attributes related to aging Americans' and younger generations' travel mode choice?
3. Do behavioral aspects play a significant role in aging Americans' and younger generations' travel mode choice?

1.4. Data and Analytical Methods

I examine how different socio-demographic, spatial, transportation, and behavioral factors might affect seniors' transportation choices by using the 2009 National Household Travel Survey (NHTS) data in this study. Sponsored by the U.S. Department of Transportation (USDOT) and administrated by the Bureau of Transportation Statistics (BTS) and the Federal Highway Administration (FHWA), NHTS is a national authoritative source for personal travel behavior that addresses who, when, where, how and why the US population travels as it does *(FHWA 2018)*. It collects trip-related data such as mode of transportation, duration, distance, and purpose of the trip. It also gathers demographic, geographic, and economic characteristics of the survey respondents. The 2009 NHTS was conducted under the sponsorship of the FHWA. Other funding agencies of the national sample of the 2009 NHTS include the Federal Transit Administration, AAA, and the Public Policy Institute of AARP. There are also twenty add-on partners who were state and metropolitan transportation planning organizations, and they funded

additional samples for their respective jurisdictions. The entire dataset contains over one hundred fifty thousand completed household interviews with approximately three hundred eight thousand completed person interviews representing over three hundred ninety-one billion trips when expanded to the whole population *(FHWA 2018)*.

Although the 2009 NHTS offers me a large size of samples to analyze aging Americans' travel mode choices, there may exist a few limitations. For instance, the Random Digit Dialing (RDD) landline sample frame used in the 2009 NHTS may not be a viable representative list of the American public. This is because more and more households have been "cutting the cord" to their landlines and relying only on cell phones. According to a recent NHTS report, "in 2009, about one-fourth of households did not have landline telephones" *(Transportation Research Board 2016, page 13)*. Therefore, travel mode choice decisions from those under-sampled households without landlines may affect my data analysis results. On the other side, my survey focuses on seniors' travel behavior; and seniors are more likely *not* to be affected by such a sampling limitation, as more senior households still use landline compared to younger generations.

The present research analyzes trips taken by seniors (>64), middle-aged boomers (45–64), and younger generations (<45). To facilitate discussion, I dichotomize different travel modes (e.g., car, SUV, local bus, taxi, subway) into two categories: auto travel vs. other non-auto travel modes, where auto travel includes trips made by car, van, SUV, and pickup truck.

I first conduct a univariate analysis to explore the variation in different factors, which may influence people's travel mode choices, across different age groups. I then conduct a logistic regression analysis to study the (joint) impact of these factors on the choices of travel mode. The

corresponding logit model is specified below in Equation 1.1, where the dependent variable (Y) indicates whether travelers choose auto as their travel mode (1 = Yes, 0 = No).

$$Logit[p(Y=1)] = \ln\left[\frac{p(Y=1)}{p(Y=0)}\right] = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n \ldots \text{ Equation 1.1}$$

The independent variables (X) include four different categories of variables: socio-demographic, spatial, transportation, and behavioral attributes. As mentioned in the conceptual framework section, the selection of these variables is based on a wide range of the prior literature on (travel) behavior researches.[3] Socio-demographic characteristics contain variables such as age, gender, household size, whether the survey respondent rents or owns the housing unit, income, and whether the survey respondents still participate in the labor force. Three built environment factors are selected to represent spatial attributes: population density (i.e., population per square mile), employment density (i.e., workers per square mile), and the size of residence area.[4] Transportation attributes include household car ownership, number of drivers in the household, whether there are any additional household members with the respondent on the trip, and travel time. Behavioral aspects represent survey respondents' opinion on the most important transportation issues: travel cost, congestion, aggressive drivers, safety, access to transit access, and access to sidewalks. The detailed variable list and type, as well as the hypothesized direction of the impact ("+" means an increase in the associated continuous variable, or, the presence of the categorical effect if for categorical variables, is associated with a

[3] As a secondary data analysis, the selection is also constrained by the availability of variables presented in the existing dataset.

[4] Residence in a urban area of at least 50,000 and less than 199,999 people is set as a reference group when generating categorical variables for the urban size variable, where living in urban area of at least 200,000 and less than 499,999 people, urban area of at least 500,000 and less than 999,999 people, urban area of one million or more people without subway or rail, urban area of one million or more people with subway or rail, or non-urbanized area is each compared to the reference group in the logit model.

higher likelihood of choosing car than other travel modes), are shown in Table 1.1. All data analyses are conducted in Stata.[5]

Table 1.1. List of Variables and Hypothesized Direction of Relationship

Variable list	Variable type	Hypothesized direction of relationship		
		Seniors (> 64)	Middle-aged boomers (45–64)	Younger generations (< 45)
Socio-demographic characteristics				
Age	Continuous	+ For all age groups		
Female (vs. male)	Categorical	+ For all age groups		
Household size	Continuous	-	-	-
Home rented (vs. home owned)	Categorical	- For all age groups		
Income	Continuous	No effect	+ For both age groups	
Working	Categorical	No effect	+ For both age groups	
Built environment factors				
Population density	Continuous	- Marginal effect for all age groups		
Employment density	Continuous	- Marginal effect for all age groups		
Urban size	Categorical	No effect	- For denser area	
Transportation attributes				
Household car ownership	Continuous	+ For all age groups		
Number of drivers in household	Continuous	No effect	+ For both age groups	
Additional household member on trip (vs. none)	Categorical	+ For all age groups		
Travel time	Continuous	+ For all age groups		
Behavioral aspects (most important transportation issue)				
Cost	Categorical	+ For all age groups		
Congestion	Categorical	+ For all age groups		
Aggressive Drivers	Categorical	+ For all age groups		
Safety	Categorical	+ For all age groups		
Transit access	Categorical	No effect	- For both age groups	
Sidewalks	Categorical	No effect	- For both age groups	

[5] http://www.stata.com/

1.5. Findings and Discussion

1.5.1. Univariate Analysis

Socio-demographic characteristics

The public data set of the 2009 NHTS contains over 308,000 survey respondents. This includes both respondents from the national sample and those from the 20 Add-on partners.[6] Therefore, the weighting factors have been used to adjust for oversampling in the Add-on areas *(FHWA 2011, page 1-3)*. As shown in Table 1.2, compared with the census data (in which there is 13% of seniors in the population), seniors (28%) are significantly oversampled before the weight adjustment. After adjusting the weight (i.e., running descriptive statistics on estimation sample), the age distribution is more consistent with the census data. Note that due to this oversample/weighting issue, all of the following analyses (both descriptive statistics and logistic regressions) are conducted on estimation sample where weights are taken into account.

Table 1.2. Age distribution before and after weight-adjusting

Age categories	Census [+] (2009)	2009 NHTS Distribution (before weight)	2009 NHTS Distribution (after weight)
Seniors (>64)	12.5%	27.9%	13.7%
Middle-aged boomers (45-64)	26.1%	36.4%	27.7%
Younger generations (<45)	61.3%	35.7%	58.6%

Note: $n_{2009\ NHTS} = 308{,}901$; [+] U.S. Census Bureau, Current Population Survey, Annual Social and Economic Supplement, 2009. Table 1. Population by Age and Sex: 2009.

Survey respondents' gender distribution varies by different age groups (shown in Figure 1.2). Fifty-eight percent of the senior group are women, and this percentage decreases as the age group becomes younger, i.e., 51 percent and 49 percent for the middle-aged boomers and the younger generations, respectively. Regarding the household size, a majority of seniors (about 83%) live alone or with one additional household member (shown in Figure 1.3). In contrast, a

[6] These partners were state and metropolitan transportation planning organizations; and they funded additional samples for their respective jurisdictions *(FHWA 2011, page 1-2)*.

majority of younger people (about 85%) who are 44 years old or less live with two or more additional household members. Figure 1.4 shows seniors and middle-aged boomers have a higher percentage of home ownership than the younger generations. These high percentages of home ownership among seniors are consistent with the aging Americans' tendency of aging in place. These differences in household composition and residences suggest it is necessary to look at their potential effects on travel mode choices for different traveler age groups.

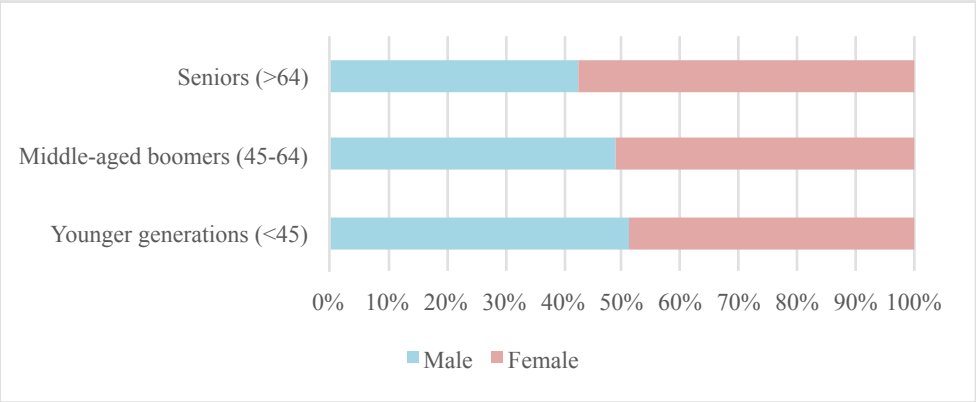


Figure 1.2. Gender distribution by different age groups
($n_{Seniors}$ = 86,112; $n_{Middle\text{-}aged\ boomers}$ = 112,402; $n_{Younger\ generations}$ = 110,387)

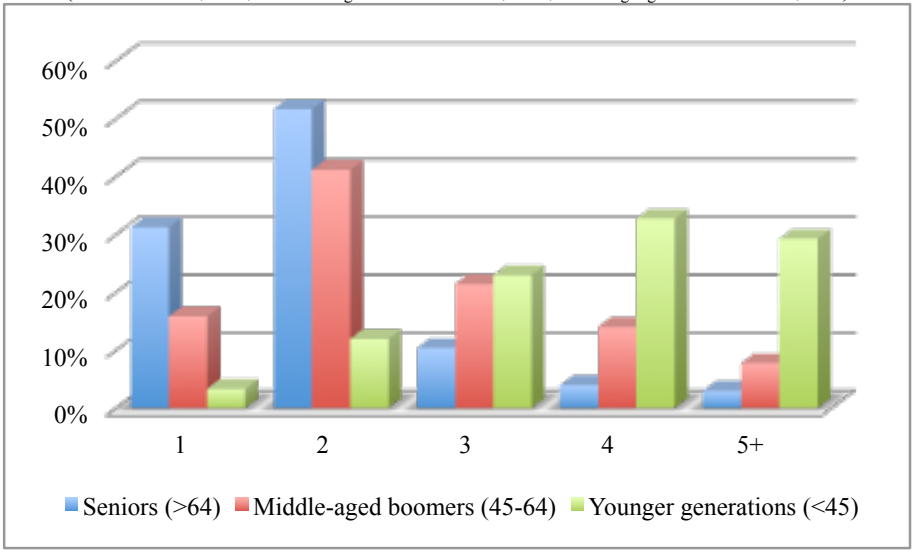


Figure 1.3. Distribution of household size by different age groups
($n_{Seniors}$ = 86,112; $n_{Middle\text{-}aged\ boomers}$ = 112,402; $n_{Younger\ generations}$ = 110,387)

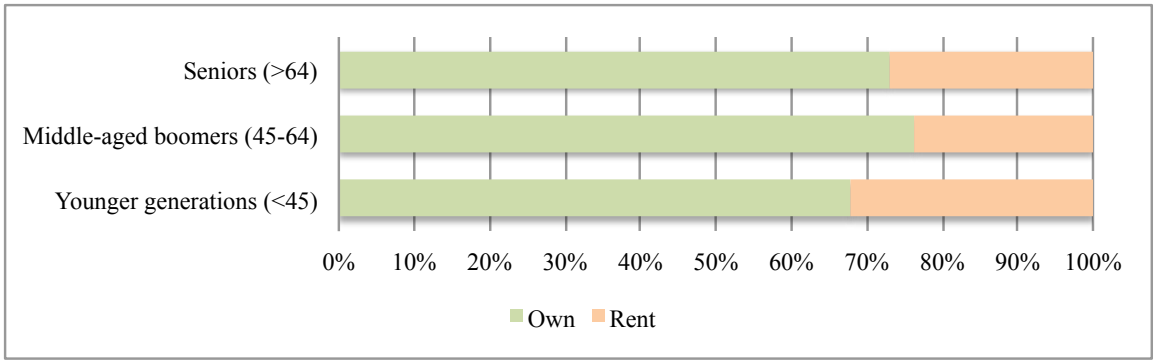


Figure 1.4. Distribution of home ownership by different age groups
(n_{Seniors} = 86,112; $n_{\text{Middle-aged boomers}}$ = 112,402; $n_{\text{Younger generations}}$ = 110,387)

I next examine the distribution of incomes across different age groups using 2009 U.S. income quintiles. Figure 1.5 shows senior age group is the least advantaged, with a majority of them (62%) falls into the first and second quintiles (i.e., less than $40,000). The middle-aged boomers and the younger generations have a more evenly distributed income, with a positive skewness towards the higher income quintiles. This significant income disparity across different age groups is further confirmed by their employment status. Figure 1.6 shows only 21% of seniors are still participating in the labor force, while over 70% of middle-aged boomers and younger generations are working. As income often influences travel choices, travel mode choices for different age groups are likely to be different.

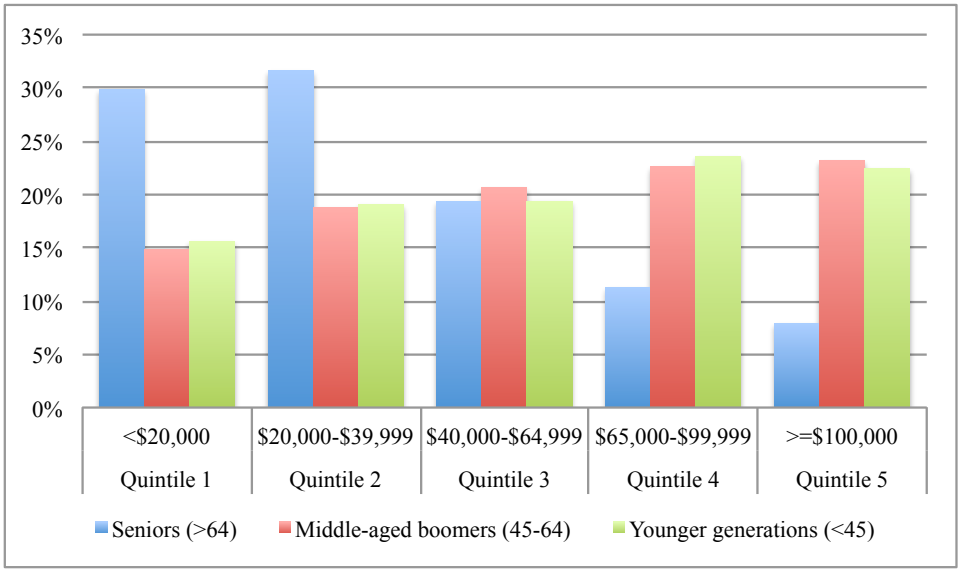


Figure 1.5. Distribution of family income by different age groups
($n_{Seniors}$ = 76,559; $n_{Middle\text{-}aged\ boomers}$ = 105,637; $n_{Younger\ generations}$ = 106,147)

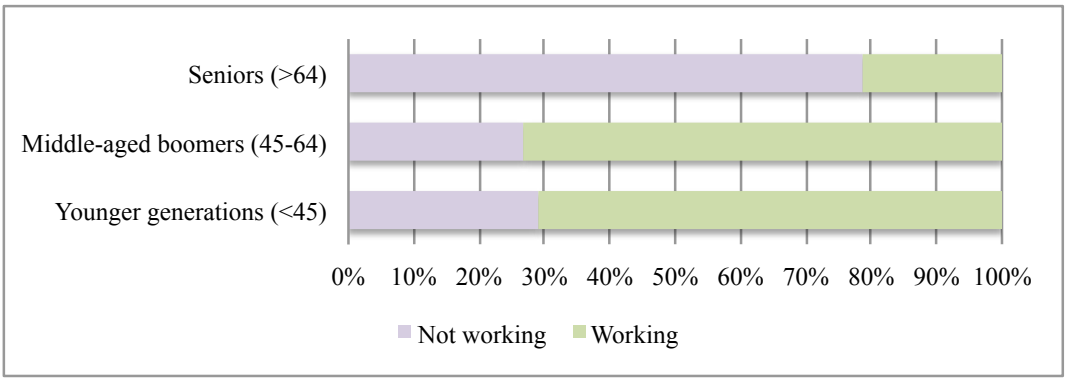


Figure 1.6. Distribution of employment status by different age groups
($n_{Seniors}$ = 86,071; $n_{Middle\text{-}aged\ boomers}$ = 112,321; $n_{Younger\ generations}$ = 72,165)

Built environment factors

As shown in Figure 1.7, the distribution of residence urban size is fairly similar across different age groups. One-third of travelers live in the non-urbanized area, making it the largest single residence urban size type. About the same percentage of travelers (20% each) live in an urban area with one million or more people either with subway/rail or without subway/rail. The remaining 30 percent of travelers spread almost equally in three different urban size areas with

lower density. These results confirm many people, including aging Americans, live in non-urbanized areas and low-density urban areas where available transportation options except for private automobile driving are quite limited.

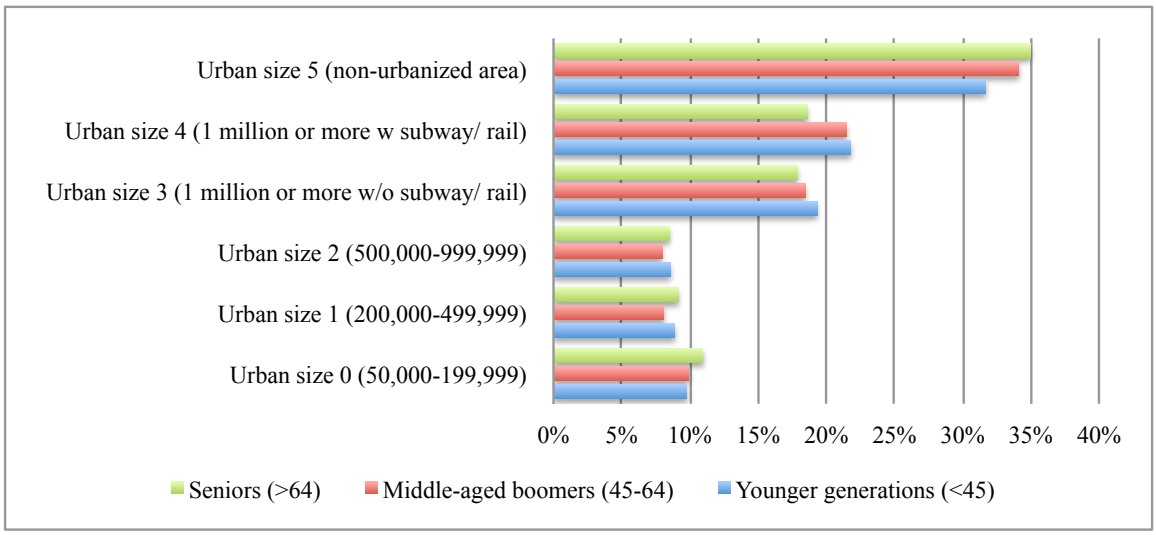


Figure 1.7. Distribution of residence urban size
($n_{Seniors}$ = 289,162; $n_{Middle\text{-}aged\ boomers}$ = 462,120; $n_{Younger\ generations}$ = 416,037)

Transportation attributes

In the public dataset of the 2009 NHTS, there are a total of 1,167,321 trips surveyed. A majority of these trips relies on the private automobiles: over 80 percent of trips are made by auto travel modes. Interestingly though, when separating data into different age groups, I find higher shares of auto travel mode in older age groups (see Figure 1.8). For instance, among younger generations, 81% of their trips are auto trips. However, for seniors, 87% of their trips are made by auto; meanwhile, the corresponding non-auto mode share decreases to only 13%. These results show many aging Americas are still on the wheels, and seniors use less non-auto travel modes than the younger age groups. This is likely due to factors such as the limited choice of available travel options, or the fact that non-auto travel presents more barriers for seniors to use than other age groups.

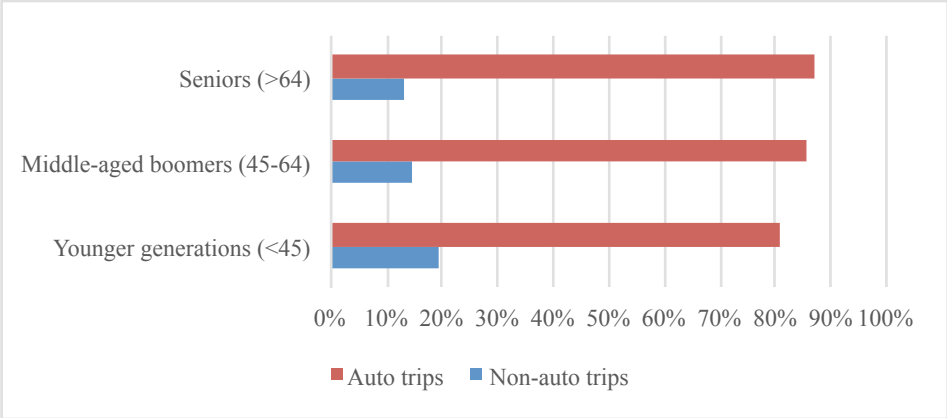


Figure 1.8. Travel mode distribution by different age groups
($n_{Seniors}$ = 288,752; $n_{Middle\text{-}aged\ boomers}$ = 461,352; $n_{Younger\ generations}$ = 415,093)

On average, there are 1.73 cars in each household with senior members, while there are 2.31 cars in households without senior members. Only 6% of senior travelers do not own a car, while 55% of them own two or more cars (Figure 1.9). At the same time, almost all senior households (96%) have at least one licensed driver. Very often, senior travelers are not alone; for instance, 31% of them are accompanied by other household members.

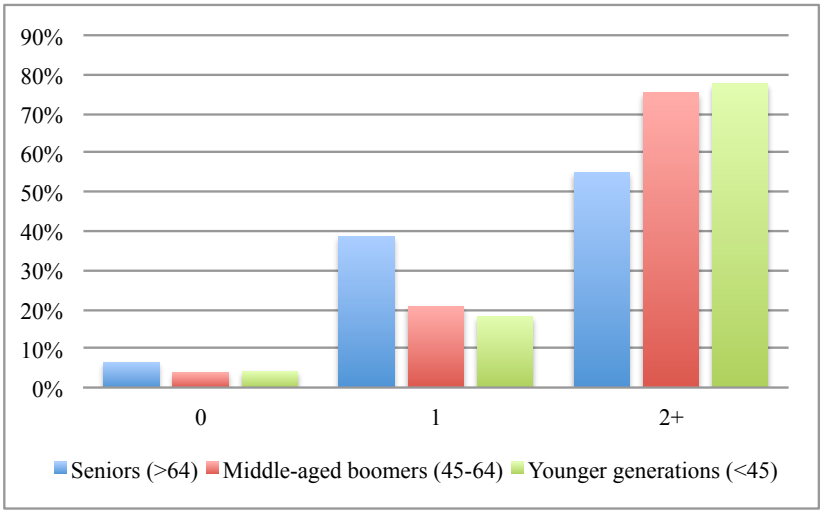


Figure 1.9. Household car ownership distribution by different age groups
($n_{Seniors}$ = 289,162; $n_{Middle\text{-}aged\ boomers}$ = 462,122; $n_{Younger\ generations}$ = 416,037)

The average travel time for seniors' trips is 19.45 minutes, which is quite close to the trip travel time of the other two age groups, 20.67 and 20.06 minutes for middle-aged boomers and

younger generations, respectively. In comparison, seniors travel 7.99 miles for each of their trips on average, which is shorter than the average of other age groups (10.46 miles for middle-aged boomers, and 9.73 miles for younger generations). These results imply seniors travel at a lower speed than the younger age groups.

Behavioral aspects

The 2009 NHTS includes a *new* question asking respondents' behavioral opinion about their travel concerns – the most important transportation issues. The question lists six (6) issues in the multiple choices/single answer formats. They are 1) the price of travel including things like transit fees, tolls, and the cost of gasoline, 2) highway congestion, 3) aggressive or distracted drivers, 4) safety concerns, like worrying about being in a traffic accident, 5) access to or availability of public transit, 6) lack of walkways or sidewalks.

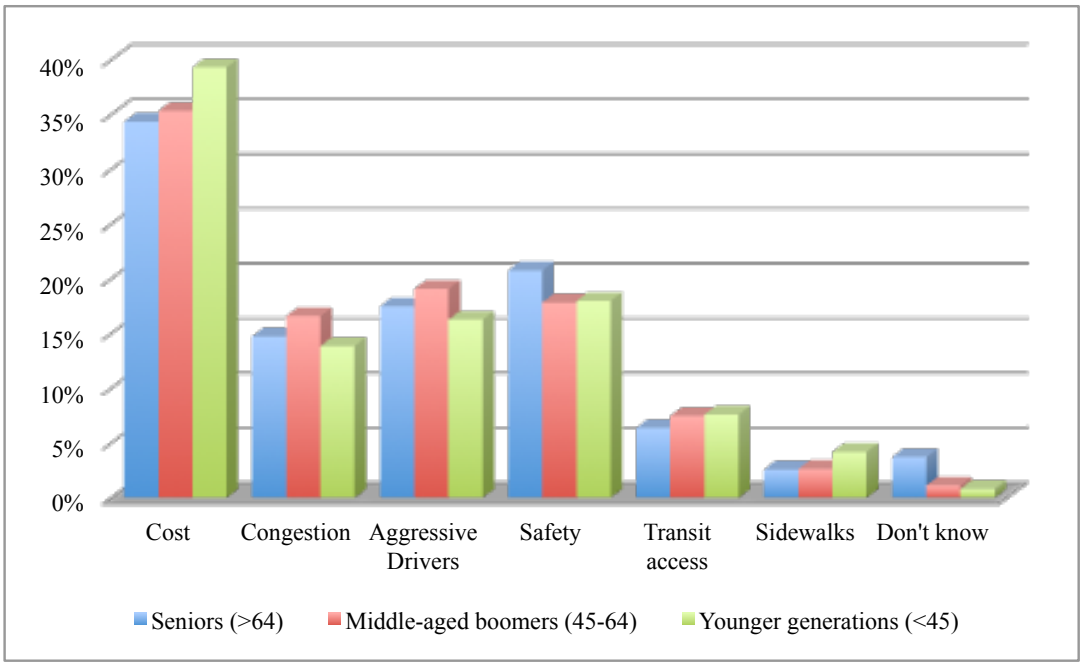


Figure 1.10. Distribution of the most important transportation issues
($n_{Seniors}$ = 251,880; $n_{Middle\text{-}aged\ boomers}$ = 402,210; $n_{Younger\ generations}$ = 234,584)

Figure 1.10 shows different age groups share relatively similar responses to these transportation concerns. Most respondents select travel cost as the most important issue to their travel, i.e., 33%, 34%, 38% of the seniors, middle-aged boomers, and younger generations, respectively. The following three categories are traffic congestion, aggressive or distracted drivers, as well as safety concerns; about 20 percent of the respondents name one of these three categories the most important issue to their travel. Not surprisingly, the lowest categories that travelers are concerned about are access to public transit and sidewalks. From a behavioral perspective, non-auto travel modes, especially public transit options, have a substantially low priority in the mind of most travelers. Moreover, seniors even concern less on the access to non-auto travel modes than the middle-aged boomers or the younger generations, suggesting less interest from seniors on using non-auto travel modes and thus significant challenges to transportation planners -- using the traditional public transportation approach as the solutions of dealing with senior transportation needs might not be effective.

1.5.2. Logistic Regression Results

Table 1.3 shows the logit model results of travel mode choice for different age groups. This analysis is based on the full data set of all trip purposes. The numbers of observations for seniors, middle-aged boomer, and younger generations are 224,670, 377,100 and 223,757, respectively. As a reminder, the dependent variable is defined as whether travelers choose auto as their travel mode (1 = Yes, 0 = No). Overall, most of the regression results support the hypothesized direction of the relationship. To summarize the detailed descriptive statistics that have been discussed in the above sections, a comprehensive descriptive statistics table including all independent variables is presented in Appendix A – Table A.1.

To check the robustness of the results, I conduct two additional analyses based on subsets of data. First, along with the aging process, seniors' major travel purposes may gradually shift from commuting to serving their daily needs, such as shopping, health care, and recreation or social activities. Trips for daily needs may better reflect seniors' travel mode choice behavior than commuting trips. Thus, I run a logit model based only on trips for daily needs. Results are shown in Appendix A – Table A.2. In addition, when people start their day using a certain type of travel mode, their following trips during that day may be constrained by this first mode they have selected. Thus, I study another logit model that only considers people's first trip of the day; in this model, for the same reason above I include only trips for daily needs. Results are shown in Appendix A – Table A.3. Indeed, both models return similar results as the model that uses the full dataset of all trip purposes, suggesting my findings are consistent across different datasets. To make discussion succinct, I focus on the model with the full dataset below.

Table 1.3. Logistic Regression Results of Travel Mode Choice

Variable	Odds ratio for different age groups		
	Seniors (> 64)	Middle-aged boomers (45 – 64)	Younger generations (< 45)
Socio-demographic characteristics			
Age	1.01930***	1.00912*	1.01530***
Female (vs. male)	1.37662***	1.27956***	1.08915
Household size[+]	0.28438***	0.60563***	0.66020***
Home rented (vs. home owned)	0.74563*	0.79013***	0.89547
Income[+]	0.97857	1.05596***	1.05049***
Working	1.13478	1.34003***	1.74268***
Built environment factors			
Population density	0.99995***	0.99995***	0.99994***
Employment density	0.99988***	0.99989***	0.99991***
Urban size 1 (200,000-499,999) [++]	1.17815	1.27067*	0.86943
Urban size 2 (500,000-999,999) [++]	1.24304	1.27402*	0.90028
Urban size 3 (1 million or more w/o subway/ rail) [++]	1.84355***	1.20955*	0.85582
Urban size 4 (1 million or more w subway/ rail) [++]	1.24447	0.95331	0.63728***
Urban size 5 (non-urbanized area) [++]	0.84710	1.04646	0.74076***
Transportation attributes			
Household car ownership	1.89828***	1.25766***	1.46036***
Number of drivers in household	1.14900	1.13413*	1.10639*
Additional household member on trip (vs. none)	19.31531***	12.48317***	13.16477***
Travel time[+]	1.08983**	0.95845	1.10709***
Behavioral aspects (most important transportation issue)			
Cost	2.20340***	1.29200	1.57584**
Congestion	2.16943***	1.57234**	2.02203***
Aggressive Drivers	2.18371***	1.75220***	1.66348**
Safety	2.66227***	1.63106**	1.97296***
Transit access	1.03486	0.59551**	0.86488
Sidewalks	1.14960	0.47064***	0.70121
Constant	0.43804	1.03124	0.55934
N	224,670	377,100	223,757

Note: odds ratio = exp (coefficient); *** $p \leq 0.01$; ** $p \leq 0.05$; * $p \leq 0.1$; [+] these independent variables (i.e., household size, income, and travel time) are taken natural log transformation in the analysis due to their positively skewed distributions; [++] residence in a urban area of at least 50,000 and less than 199,999 people is set as a reference group when generating categorical variables for the urban size variable, where living in urban area of at least 200,000 and less than 499,999 people, urban area of at least 500,000 and less than 999,999 people, urban area of 1 million or more people without subway or rail, urban area of 1 million or more people with subway or rail, or non-urbanized area is each compared to the reference group in the logit model.

Socio-demographic characteristics and mode choice

It is found that all age groups, including seniors, are more in favor of auto travel when becoming older. For instance, with a five-year increase in age, the odds of seniors choosing auto travel increase by about 10 percent, holding other variables constant. These results confirm my hypothesis that most Americans, especially those who are seniors, are still auto-dependent. Thus, the stereotype planning thoughts of providing seniors with more public transportation when they get older are questionable. This brings up an important debate about whether traditional public transportation should be the focus of transportation policies to assist senior populations, or it is necessary to introduce new and innovative auto-like travel options to aging Americans.

For seniors and middle-aged boomers, women are more likely to make auto trips than men, and these results are consistent with findings in the literature. On the one hand, women are generally more risk-averse than men, and they value safety more when they make decisions on mode choice *(Byrnes, Miller, and Schafer 1999)*; on the other hand, in general women take more responsibility for family duties, such as taking children to/from school, doing grocery shopping. Therefore, due to the safety and convenience concerns, women are more likely to use auto travel than other travel modes such as public transit and taxi. Interestingly, however, there are no gender differences regarding travel mode choice for younger generations. This is possibly because women in the younger generations are more independent than before, and there is a growing trend that women and men are sharing family responsibilities more than before.

Seniors and middle-aged boomers with larger household sizes or who rent their homes are less likely to use auto travel. It is possible these people have a lower socio-economic status and rely more on public transportation. However, household income itself is not a significant factor for the senior population. One potential explanation is that compared to the younger

population, seniors' socio-economic attributes are more homogeneous and thus there is no significant variation in household income. The 2009 NHTS survey data confirms this explanation: over 80 percent of senior households' income is less than $65,000, while almost half of the younger households have an income of $65,000 and above. Consistently, whether the survey respondent is participating in the labor force is positively associated with the auto mode choice for middle-aged boomers and younger generations, but not for the seniors. In other words, whether seniors are still working does not affect their travel mode preferences.

Built environment factors and mode choice

The results show the effects of population and employment density are statistically significant; however, the magnitude of effects is fairly marginal. For instance, even when population density increases by five hundred per square mile, the odds of choosing non-auto travel modes for senior respondents living in the area is only about 2% higher. These marginal effects may be because the NHTS data are nationwide data that may not be able to catch the effects from high-density areas.

Moreover, when looking at the detailed urban size variable that not only considers population but also encompasses residential, commercial, and other non-residential urban land uses, the regression results vary significantly among different age group. To be specific, compared with the reference urban area (at least 50,000 and less than 199,999 people), middle-aged boomers prefer to make more auto trips even if there are more people and more urban land use mixes unless the urban area offers convenient public transit such as subway and rail. Younger people prefer non-auto travel mode if they reside in an urban size with one million or more people and with subway and rail; otherwise, there is no mode choice difference among

different urban sizes compared with the reference group. These results imply although the urban size variable shows different effects on middle-aged boomers and younger generations, a good public transit system does matters for these two age groups.

In contrast, urban size does not seem to affect seniors' mode choice, even if the urban area has a subway or rail transit system. This confirms the above results from the analysis of population and employment density that built environment factors are somehow inelastic for seniors when they make travel mode choice decisions, even if the urban area they live in offers comprehensive public transit system (indicated by having subway and rail). To some extent, these results imply increasing density alone might not be an effective strategy to change individuals' travel mode choice, at least not for the current generation of aging Americans.

Transportation attributes and mode choice

People living in households with more cars, including seniors, are more likely to use auto travel. For middle-aged boomers and younger generations, more drivers in the household are positively associated with more auto trips; however, it does not affect seniors travel mode choice. This is possibly because a majority of seniors live along and with only one additional household member. If there are additional household members traveling with the respondent for the trip, they are much more likely to use auto. With additional family members on the trip, the odds of using auto are over nineteen times than the situation without. Furthermore, travel time is positively associated with auto mode choice for seniors and younger generations, but not for middle-aged boomers. It is possible many trips made by middle-aged boomers are rigid, such as commuting trips. Similarly, even if middle-aged boomers value travel cost as an importation transportation issue, they would not change their travel mode choice accordingly. These results

show middle-age boomers are somehow inelastic to travel attributes such as travel time and travel cost.

Behavioral aspects and mode choice

As expected, different behavioral considerations regarding transportation (mode choices) are observed among different age groups. For seniors and younger generations, respondents who view the price of travel as the most important transportation issue are more likely to be those making auto trips, so as those who concern about highway congestion, aggressive and distracted drivers, and travel safety. In contrast, factors such as accessibility and availability of public transit, and lack of walkways or sidewalks are not statistically significant for seniors and younger generations. These distinctions among different behavioral aspects imply it may not be an easy job for transportation planners to encourage more non-auto travel mode choices, especially for seniors, by improving the non-auto travel conditions such as increasing the availability or accessibility of public transit or providing convenient and comfortable sidewalks.

However, Table 1.3 also shows, if middle-aged boomers value those two non-auto travel mode related behavioral aspects (i.e., availability and accessibility of public transit and sidewalks), they would be more likely to choose non-auto as their travel mode. Since the middle-aged boomers will continue to be a significant contributor of American's population aging, this result presents transportation policymakers a potential opportunity to boost more non-auto use among the middle-aged boomers by enhancing the availability and accessibility of public transit and sidewalks.

Nonetheless, these behavioral aspects surveyed in the 2009 NHTS are relatively simple. As a result, these behavioral questions may not fully capture the senior age group's concerns

about their travel. For instance, many of the current generation of aging Americans prefer aging in place. Therefore, they may not concern themselves much about congestion or availability of the traditional public transportation but instead place more value on any transportation options that could help them maintain their independence around their homes as long as possible.

1.6. Summary and Future Work

The objective of this study is to examine aging Americans' travel mode choice. When thinking about ways to improve the senior population's travel, many suggest an investment in public transportation. But is this the right solution? By analyzing the 2009 NHTS data, this present study suggests the answer may be "no."

There is strong evidence Americans, including seniors, are more in favor of auto travel when becoming older. Seniors are still driving, and their auto mode shares are even higher compared with the younger generations. Seniors prefer auto travel than public transportation, and their choices of auto travel are inelastic to the availability of comprehensive public transit systems such as subway or rail. Socio-demographic characteristics such as income and employment status do not affect seniors' mode choice preferences. Many Americans, including seniors, live in non-urbanized areas or low-density urban areas; effects of density measures on seniors' mode choice are quite marginal. Household car ownership, additional household members on the trip, and travel time are positively associated with seniors' auto mode choice. From a behavioral perspective, people's most important concern on transportation issue has different effects on mode choice among different age groups. Most interestingly, seniors would not change their travel mode choice even if they see accessibility or availability of public transit or lack of walkways or sidewalks as the important transportation issue to them; however, middle-

aged boomers who name these two issues as their most important concerns would be more likely to choose non-auto as their travel mode.

The baby boom generation has been approaching their retirement. Most of them received their driver's licenses at the age of sixteen—a time when highways were reshaping urban land patterns. For those living in urban edges, suburbs and rural areas, automobile driving has always been a way of life. However, as they age and encounter biological and physiological changes, they most likely need alternative sources of transport. Although improving traditional public transportation is important, helping aging Americans, especially those live in low-density areas with limited transportation alternatives, to travel using their preferred means is essential.

The results and discussions presented here suggest several directions for future work in the area of senior transportation planning. For instance, a behavioral survey study that focuses more on senior transportation and explores transportation options for the aging population is likely to be fruitful. Literature shows behavioral factors could have important roles in people's decision making in travel mode choices. Such impacts can be even higher for the senior population since they value travel as an essential way to maintain their independence. However, the analyses of effects of behavioral aspects on seniors' travel mode choice in this research are somehow limited by the questions used in the 2009 NHTS. Therefore, it is interesting to construct a behavioral survey specifically targeting senior transportation options and to examine the opinions of seniors, caregivers of older persons, and younger people.

Developing appropriate transportation support for the senior population is indeed an urgent task for transportation policy makers and planners. This study suggests planners need to promote senior-centric transportation solutions since seniors have quite different travel mode preferences compared to other age groups. After all, with the continuing population aging

process, the ultimate goal of transportation policies and practices is to bring seniors convenient and cost-effective transportation services no matter what socio-economic status they have and where they live. This study confirms traditional public transportation may not work for senior travelers; planners and service providers need to develop innovative senior transportation solutions (e.g., auto-like alternatives) while balancing individual's preferences and affordability.

Essay Two: Surveying Aging Americans' Transportation Options in the Crowdsourcing Age: A Survey Experiment through Amazon Mechanical Turk

Abstract

A rapidly aging population in the United States has made baby boomers' travel needs a top priority for both public and private transportation agencies to consider. This group of aging Americans has been on the wheels since the age of sixteen, and there is no evidence showing that they are giving up private auto travel soon. What challenges transportation planners, operators, and service providers the most is figuring out aging Americans' travel needs in a timely manner in order to promptly provide them with better transportation access as they age. Due to such time sensitivities, conventional methods, which usually rely on costly and time-consuming in-person or telephone interviews and travel diary survey questionnaires, may not be efficient nor effective to explore aging Americans' travel behavior. To address these challenges, my research constructs a comprehensive survey questionnaire specifically targeting aging Americans' transportation options using an innovative crowdsourcing platform—Amazon Mechanical Turk (MTurk). The results show my survey is able to gather meaningful insights on senior transportation options from different categories of respondents, including seniors, younger caregivers of elderly dependents, and younger people who are not caregivers, in a relatively short time frame. These respondents represent either current or future customers of senior transportation services. In addition, survey data collected from the MTurk platform represent a fairly diversified population; the data are able to capture respondents from different socio-demographic categories and share a similar distribution pattern like those seen in the general population data (e.g., Census) and the large-scale nationwide transportation survey using random sampling method

(e.g., National Household Travel Survey). These findings indicate Amazon MTurk could be a valuable crowdsourcing platform for planning-related surveys, experiments, and data collections, especially when addressing timely issues such as aging Americans' travel needs.

Keywords: Population Aging, Senior Transportation, Travel Behavior, Survey, Amazon Mechanical Turk (MTurk)

2.1. Introduction

As discussed in Essay One, a rapidly aging population brings tremendous challenges to the transportation planning, operating, and service sectors. While no evidence shows aging Americans are giving up driving, seniors demand better transportation access as they age. There are extensive travel behavior studies on the national, regional, or local levels, but these studies usually target at general populations. To plan and implement transportation options that meet the specific needs of seniors, more in-depth investigation is required to understand the aging population's travel behavior. In addition, a wide range of innovative transportation options for seniors has been developed recently by either public agencies or private companies[7] *(Dize 2013; Freund 2013)*. However, we know relatively little about whether seniors are aware of these options and willing to use them. Therefore, it is important to examine how to increase seniors' awareness of available transportation options and also to encourage seniors to use existing and new options. This essay explores these issues by designing and implementing a comprehensive survey to study Aging Americans' Transportation Options.

[7] Examples of these innovative senior transportation options are elaborated in Essay Three.

Understanding travel behavior is crucial in both transportation planning and management processes. In the planning process, one should consider different travelers' preferences (e.g., travel mode choice) in order to plan various transportation infrastructure and alternatives for different user needs. In the operation process, one needs to have a clear picture of travel patterns in order to effectively manage the comprehensive transportation network that contains not only highways and automobiles but also the transit systems, bicycles, and pedestrians. The conventional way to understand travel behavior is through survey studies, in the form of in-person interviews, mail-in survey questionnaire, dial telephone interview, and recently, on-line survey questionnaires *(Travel Survey Methods Committee 2016)*. Although data reliability and the generalizability of survey results of the newly developed online survey method has been questioned, it remains one of the most commonly used research methods nowadays to understand travel behavior, particularly due to its easy and quick data collecting process and its lower cost compared to other methods *(Bayart and Bonnel 2015; Susilo et al. 2017)*.

Most recently, Amazon Mechanical Turk (MTurk) has been utilized in many research fields, especially in social science, to conduct survey studies. For instance, it has been used in the studies of consumer behavior, sociology, and psychology *(Berinsky, Huber, and Lenz 2012)*. These studies show the MTurk provides a useful platform to study the behavioral decisions of a general population. The field of transportation planning, however, has not taken full advantage of this convenient web-based platform for travel behavioral research. My study aims to fill in such a literature gap; and more specifically, I will test the applicability of the Amazon MTurk platform in the field of travel behavior research.

Following the full scope of my research, I intend to conduct a behavioral survey on the Amazon MTurk platform to investigate seniors' travel preferences and their attitudes towards

new transportation options. I search for three types of respondents: 1) senior respondents; 2) younger respondents who are caregivers of an elderly dependent; and 3) younger respondents who are not caregivers. Opinions from these three types of respondents help planners not only to examine the existing conditions of senior transportation but also to explore potential future complications of senior transportation in advance. Through the Amazon MTurk platform, the MTurk workers are recruited and categorized into one of these three respondent types. A comprehensive survey questionnaire is designed for each type of respondents. Once the survey respondents identify their age category and select whether they are caregivers of an elderly dependent, they are assigned a set of questions that match their type. Survey respondents are then asked to answer these questions, which are related to seniors' transportation reality, their preferences on travel, and their attitudes towards new transportation options. Detailed survey methods of my study will be discussed below.

The remainder of this essay is organized as follows. In section 2.2, I review the literature on travel surveys and survey methods used for travel behavior studies; I also explore the literature of survey studies utilizing the Amazon MTurk platform. In section 2.3, I elaborate my survey questionnaire design as well as the survey implementation on the Amazon MTurk platform. In section 2.4, I analyze my survey data and compare them with the Census and the National Household Travel Survey. In section 2.5, I summarize my survey of seniors' travel behavior through the Amazon MTurk platform and discuss potential future research directions.

2.2. Literature review

2.2.1. Travel surveys and survey techniques used for travel behavior studies

Nationwide travel surveys

Survey and survey analysis have been used in the planning field for decades *(Hall 2014)*. Transportation planning in the U.S. has a long history of conducting surveys as well. In 1930–1940 and 1951–1959, travel surveys that primarily focused on automobile and truck travel were conducted in some states in order to understand personal travel patterns *(FHWA 2018)*. The first Nationwide Personal Transportation Surveys (NPTS) was conducted in 1969–1970. For more than five decades since then, the NPTS and the National Household Travel Surveys (NHTS) have served as the primary national data inventory of daily travel. These surveys represent authoritative national sources for personal travel behavior that addressed who, when, where, how and why the U.S. population travels *(FHWA 2018)*. As the primary source of information about how Americans travel, the NPTS and NHTS are important travel surveys that have been conducted every five to seven years by the U.S. Department of Transportation. It helps policymakers and transportation planners to understand Americans' travel and the role of travel in their daily lives. The most recent one was deployed in 2016–2017 (data was just released in March 2018), which updates the information gathered in the 2009 NHTS, 2001 NHTS, and prior NPTS that were conducted in 1969, 1977, 1983, 1990 and 1995, respectively.

To collect survey data, transportation planners and researchers have used a variety of methods. Commonly used methods include personal interviews, telephone interviews, and self-administered survey questionnaires distributed by different means *(Travel Survey Methods Committee 2016)*. Table 2.1 listed the survey techniques used in the past NPTS and NHTS. In the beginning, these surveys were administered by the field staff of the Census Bureau in face-to-

face home interviews using a pencil and paper questionnaire. The sampling frame was the clustered Primary Sampling Units (PSU) from retired Census surveys, and these surveys yielded high response rates. Starting from the 1990 NPTS, the interviews have been assisted by the technique called Computer-Assisted Telephone Interviewing (CATI); and a new sample called Random Digit Dialing (RDD) sample was used to collect more representative travel data throughout the country. However, the survey response rate decreased significantly. Another important change over time is that instead of the Bureau of Census, those later surveys were outsourced to and conducted by third-party statistical survey research institutes or corporations. One interesting feature of the new 2017 NHTS was that in addition to the traditional phone-based surveys, survey participants might respond to the survey online, which provided a more convenient channel for survey respondents to participate and also improved the efficiency of survey data processing.

Table 2.1. Survey techniques used in the NPTS/NHTS

Survey Year	Survey method(s)	Response rate	Survey Contractor(s)
1969	In-home interviews (some telephone follow-up); Primary sampling units	Not available	Bureau of Census
1977	In-home interviews (some telephone follow-up); Primary sampling units	85.3%	Bureau of Census
1983	In-home interviews (some telephone follow-up); Primary sampling units	94.0%	Bureau of Census
1990	Computer-Assisted Telephone Interviewing (CATI); Random Digit Dialing (RDD) sample	73.1%	Research Triangle Institute, NC
1995	Computer-Assisted Telephone Interviewing (CATI); Random Digit Dialing (RDD) sample	37.2%	Research Triangle Institute, NC
2001	Computer-Assisted Telephone Interviewing (CATI); Random Digit Dialing (RDD) sample	41.0%	Westat, MD; Morpace, MI
2009	Computer-Assisted Telephone Interviewing (CATI); Random Digit Dialing (RDD) sample	19.8%	Westat, MD
2017	Households were randomly selected from a list of residential addresses; all selected households are first contacted by mail or phone; respond to the survey online or by phone	15.6%	Westat, MD

Source: 2009 National Household Travel Survey User's Guide, Page 3-5 to 3-13; 2017 NHTS Data User Guide, Page 46.

Regional travel surveys

Besides the nationwide travel surveys, there have also been many travel surveys conducted by metropolitan areas, states, and localities. For instance, sponsored by the Bureau of Transportation Statistics and the Federal Highway Administration (FHWA)[8], Metropolitan Travel Survey Archive[9] stores many of these historical surveys and makes them publicly available via the Internet. For example, the Puget Sound Regional Council (PSRC) 2006 Household Activity Survey studied regional residents' travel activities and travel preferences using a two-day travel activity diary and a questionnaire containing attitude questions and a

[8] Both are parts of United States Department of Transportation.

[9] Based at the University of Minnesota. http://www.surveyarchive.org/

stated preference/choice experiment *(PSRC 2016; Cambridge Systematics, Inc. 2007)*. Similar to the nationwide travel surveys, many of the recent regional and local travel surveys used survey techniques such as Computer-Assisted Telephone Interviewing (CATI) and the Random Digit Dialing (RDD) samples.

In contrast to the traditional, less frequent larger-scale travel surveys, many regional agencies have recently been conducting more frequent but smaller-scale travel surveys. For instance, the San Francisco Municipal Transportation Agency (SFMTA) has been conducting travel decision surveys (TDSs) on an annual basis since 2012 *(SFMTA 2017; Fehr & Peers Transportation Consultants 2017)*. Each year the TDS collects responses from approximately 750 Bay Area residents. The main objective of the annual TDS is to collect people's travel decisions and to explore the reasons behind them, so as to monitor whether the trend of travel mode share meets the regional strategic goal towards a more sustainable future (SFMTA 2013; Maguire 2017).[10]

Another example is the PSRC multi-year household travel survey program. During 2014 and 2015, PSRC planned a three-phase travel study, containing the spring 2014 household survey, the fall 2014 college (students and staff) survey, and the spring 2015 household survey *(RSG 2015)*. The first phase survey was a traditional large-scale travel diary survey targeted more than 6,000 households throughout the whole region. The second phase captured travel features of university students and staff, a population that was often underrepresented in typical household travel studies. The last phase was a booster survey containing several interesting and unique features. First, the survey sample included some households who participated in the spring 2014 household survey, which generates valuable longitudinal data set for the regional

[10] The FY 2013 - FY 2018 SFMTA Strategic Plan (Strategic Objective 2.3: Mode Share) sets the target at 50 percent trips by private automobile and 50 percent trips by non-private auto modes, such as walking, biking, transit, taxis, and carshare *(SFMTA 2013)*.

travel studies. Second, it also recruited new household in the sample to collect cross-sectional data more frequently. Third, perhaps the most interesting feature of the 2015 spring survey is that it carried out a smartphone-based GPS survey using a small sample drawn from the households who completed the spring 2014 travel study. The purpose of this is to assess the feasibility of full employment of smartphone-based data collection techniques in future travel surveys *(PSRC 2017b)*. Building upon many of its early travel survey studies, PSRC has currently been conducting and planning a six-year survey program for three waves (i.e., three two-year cycles for 2017, 2019, and 2021 respectively). These multi-year travel surveys are believed to continue supporting the data collection and analysis needs in a wide variety of planning agencies *(PSRC 2017a)*.

As the above review shows, across many planning agencies, there exists a trend of conducting smaller surveys at a regular basis and short intervals rather than administering traditional large-scale surveys every six to ten years. On the one hand, this is a more cost-effective approach to allocate the already tight planning budgets. On the other hand, more frequent travel surveying collects travel data in a timelier fashion so that these up-to-date travel data can be used to more effectively monitor and manage (regional) travel patterns. In addition, with the accumulation of more frequent travel data, researchers and planners can better analyze travel behavior changes over time, evaluate possible reasons behind them, and search for potential solutions promptly.

Other travel surveys

There are many small-scale independent travel behavior surveys conducted by researchers, practitioners, and even private sectors. These travel surveys generally have a much

broader range of objectives and contents. They may target at survey respondents with specific socio-demographic backgrounds, e.g., children, seniors, woman, students, and low-income groups *(McDonald et al. 2013; Siren and Haustein 2016; Hohenberger, Spörrle, and Welpe 2016; Emond and Handy 2012; Rodriguez and Joo 2004; de Lima, Leonor Maia, and Lucas 2017)*. They may have study interests in specific travel modes, e.g., private cars, transit, walking, biking *(Karlsson 2017; Fan, Guthrie, and Levinson 2016; Kang et al. 2017; Emond and Handy 2012)*. They may focus on particular types of travel behavior – commuting trips, school trips, leisure trips, and parking, etc. *(Khattak, Koppelman, and Schofer 1993; Frater et al. 2017; Dominik, Carsten, and Claudia 2017; Douissembekov et al. 2014)*. Alternatively, they may have distinct purposes for the study—identifying factors that affect travelers' mode choice(s), evaluating the outcomes of policy interventions, or analyzing user experience of programs/services *(Khattak and Rodriguez 2005; Jia et al. 2017; Goldwyn 2017)*.

Many of these independent travel behavior studies have been utilizing the traditional survey techniques as in the national and regional travel surveys. Some studies design travel diary questionnaires and implement the survey by mail *(Khattak and Rodriguez 2005; Douissembekov et al. 2014; Song et al. 2017)*. Some conduct personal interviews or focus group studies to gather more in-depth information from the respondents *(Werneke, Dozza, and Karlsson 2015; Prat et al. 2017; de Lima, Leonor Maia, and Lucas 2017)*. However, there have been more and more travel behavioral studies practicing and experimenting innovative survey methods, including mix-methods *(Bayart and Bonnel 2015; Susilo et al. 2017)*, smartphone *(Comendador and López-Lambas 2016; Allström, Kristoffersson, and Susilo 2017)*, GPS *(Jones et al. 2009; Kang et al. 2017)*, and socio-media *(Zhang, He, and Zhu 2017; Rashidi et al. 2017)*. These innovative survey techniques have been confirmed to be feasible and useful complements to the traditional

travel diary collection methods. Compared to conventional household travel surveys, data collection through these innovative methods is usually less expensive and easier to implement. Some of these methods can make more inclusive, complete, door-to-door, travel survey measurements. It is worth noting, though, different survey methods may perform better in different dimensions. One of the important advantages of using some of these innovative methods is that they can monitor the individual's longitudinal travel behavior features over a much longer observation period.

Summary

Travel surveys have been used for travel behavioral studies at different scales, with diverse objectives and contents, and via various surveying techniques. Most national and regional planning agencies rely on large-scale travel diary surveys, which maintain the random sampling frame but are often costly and time-consuming. On the contrast, there have also been a significant number of independent travel behavior studies that start exploring non-traditional survey methods such as convenience samples and Internet samples, which are typically less expensive and more convenient to get and can be collected in a timelier manner. Although the generalizability feature of random sampling is desirable, when facing new or dynamic planning issues, small-scale (pilot) surveys using cost-effective and innovative methods can help planners and practitioners to quickly identify potential problems first and then to search for potential solutions. Therefore, with the rapidly progressing population aging, these innovative surveying methods might work better than traditional large-scale surveys in order to promptly identify and tackle senior transportation issues.

2.2.2. Amazon MTurk platform in survey research

Amazon Mechanical Turk (MTurk) is an online "marketplace for work that requires human intelligence."[11] More specifically, it is a web-based platform where "requesters" can post Human Intelligence Tasks (HITs)[12] and recruit diverse and on-demand "workers" to complete these tasks quickly and at a relatively inexpensive cost. Amazon MTurk has recently been used by researchers, mostly in psychology, behavioral studies, and social sciences *(Berinsky, Huber, and Lenz 2012)*. It provides researchers with a means to recruit individuals for experiments or to conduct web-based surveys.

Advantages of employing Amazon MTurk include but are not limited to the following: it has a large participation pool; it offers a streamlined process of study design, participant recruitment, and data collection; and it has an integrated participant compensation system *(Buhrmester, Kwang, and Gosling 2011)*. MTurk now has more than five hundred thousand "workers" throughout the world.[13] Once researchers create a "requester" account on the Amazon MTurk website and deposit funds into the account, they can start to post their research tasks as HITs and to recruit MTurk "workers" to work on these HITs right away. Amazon will then handle the compensation payments.[14] The typical cost is under one dollar per completion of a five-minute HIT, which is significantly lower compared to traditional methods *(Buhrmester, Kwang, and Gosling 2011)*.

In terms of data quality, Buhrmester and his colleagues claim "MTurk can be used to obtain high-quality data inexpensively and rapidly" *(Buhrmester, Kwang, and Gosling 2011,*

11 https://www.mturk.com/mturk/help?helpPage=overview

12 such as identifying objects in a photo or video, performing data de-duplication, transcribing audio recordings, or researching data details

13 https://requester.mturk.com/tour

14 Amazon now collects 20 percent commission from requesters on all payments; HITs with 10 or more assignments will be charged an additional 20 percent fee on the reward you pay Workers (https://requester.mturk.com/pricing).

page 3). Their analysis shows the data obtained from Amazon MTurk is at least as reliable as those obtained via traditional methods. They also found realistic compensation rates do not affect data quality, but participation rate is affected by compensation rate and task length. Berinsky and his co-authors state the MTurk sample does not present a wildly distorted view of the U.S. population; and it is attractive as a means for conducting internally valid experiments *(Berinsky, Huber, and Lenz 2012)*. Compared with a representative sample of a population, say, a random digit dialing telephone survey sample, Simons and Chabris *(2012, page 4–5)* found "studies on MTurk can provide a nationally representative sample using the same weighting procedures used for telephone polling."

However, no method is perfect, and the Amazon MTurk experiment/survey platform has drawbacks as well. There are possible self-selection concerns *(Berinsky, Huber, and Lenz 2012)*. Without proper weighting mechanism, MTurk sample may contain younger and more female subjects compared to the general population *(Paolacci, Chandler, and Ipeirotis 2010)*. Nonetheless, there have been a large number of quantitative replication studies showing that results collected via Amazon MTurk are reasonably compatible with data collected from traditional means, such as physical labs, convenience samples, internet samples, face-to-face interviews *(Mason and Suri 2012; Paolacci, Chandler, and Ipeirotis 2010; Rand 2012; Berinsky, Huber, and Lenz 2012; Paolacci and Chandler 2014)*.

There are only a limited number of transportation planning related studies that have used the Amazon MTurk tool. For instance, one group of researchers conducted a route choice experiment on MTurk in the spring of 2013. They recruited participants there and asked them to make route choice decisions based on the official and six alternative hypothetic Washington DC subway maps *(Guo et al. 2017)*. The experiment via MTurk demonstrated the possibility of using

subway maps as a low-cost planning tool to gather information on passenger route choice and to guide future planning processes. Another group of researchers designed a pedestrian receptivity questionnaire to access pedestrian receptivity toward fully autonomous vehicles *(Deb, Strawderman, Carruth, et al. 2017)*. The questionnaire, containing items about attitude, social norms, trust, compatibility, and system effectiveness, was distributed on MTurk. The same group of researchers also successfully tested a pedestrian behavior questionnaire using survey respondents recruited via MTurk to evaluate pedestrian behavior at crosswalks *(Deb, Strawderman, DuBien, et al. 2017)*. In addition, there have been studies utilizing MTurk platform to conduct consumer surveys on electric vehicles *(Krupa et al. 2014; Helveston et al. 2015)*; some researchers used MTurk to recruit part of their survey respondents in order to examine user preferences regarding autonomous vehicles *(Haboucha, Ishaq, and Shiftan 2017)*. As indicated by the literature above, the Amazon MTurk can be a valuable crowdsourcing platform to help test or validate planning-related surveys and experiments.

2.3. Design of the Amazon MTurk Survey Experiment

2.3.1. Survey questionnaire

As suggested by earlier research, Amazon MTurk workers, similar to standard Internet survey respondents, tend to be younger *(Paolacci, Chandler, and Ipeirotis 2010)*. Therefore, a comprehensive survey questionnaire is designed to catch more respondents' thoughts on senior transportation options. My MTurk survey targets three types of respondents: 1) senior respondents; 2) younger respondents who are caregivers of an elderly dependent; and 3) younger respondents who are not caregivers. The first two types of respondents can help us understand the existing conditions of senior transportation; and all respondents, especially the third type of

respondents, can help us explore potential future complications of senior transportation in advance. Appendix B shows the final version of my survey questionnaire. At the beginning of the questionnaire, the survey respondents first self-identify their age category and select whether they are caregivers of an elderly dependent; then they are assigned a subset of questions that match their own situations. The survey questions contain the following categories: socio-demographics, health, living environment, transportation reality, preference on travel, and their attitudes towards new transportation options. Some of the featured questions in each category are highlighted in Table 2.2 below.

Table 2.2. Example questions in the Amazon MTurk survey questionnaire

Categories	Example Questions
Socio-demographics	Age, Gender, Race, Income, Education, Employment
Health	Health condition, Health insurance, Impact of transportation on access to health services
Living environment	Density, Accessibility (shopping, health services, recreational, and social), Household features, Housing
Transportation reality	Driving or not, Travel options used in the past year, Travel frequency, Typical travel time, Most used travel option and factors behind, Home delivery service
Preference on travel	Travel support services provided by different stakeholders (e.g., community, public, private, or family members)
Attitudes towards new transportation options	Likelihood of trying/using new transportation options if information about these options is disseminated by different stakeholders (e.g., community, public, private, or family members)

The socio-demographic information can help us to understand the basics of MTurk survey respondents. In addition, we can compare such an Internet sample with the existing and traditional survey samples that have been used in the travel behavioral research field. For instance, we can compare the distributions of age, gender, income, and education in the MTurk

sample with those in the NHTS and Census data. We can then evaluate whether the MTurk survey data is a reasonable data source for travel behavior research.

Health conditions pose significant constraints on one's travel choice; conversely, travel habits (e.g., auto-dependent lifestyle) affect one's health conditions as well. This reciprocal relationship between people's daily travel and their health becomes more conspicuous for the aging population. One the one hand, aging people tend to (gradually) have more medical conditions than younger generations. On the other hand, most older adults in the United States started driving at the age of sixteen; such a lifestyle (i.e., lack of everyday physical activities) contributes many of today's predominant health problems (e.g., cardiovascular diseases (CVDs), diabetes mellitus, obesity) *(Sallis et al. 2012)*. Since seniors are the focus population in this research, it is helpful to explore survey respondents' health conditions.

Built environment, which decides people's trip origin and destination, is always tied with transportation planning and practice. One cannot examine transportation options without considering the living environment in which travelers live, work, shop, recreate, and socialize.

Seniors are expected to have different travel features from younger generations. Therefore, questions in the transportation reality category intend to explore whether respondents are (still) driving; what types of travel options they have used in the past; what are their travel characteristics (e.g., travel frequency, travel time); what is their most used travel option and why they used such an option; and, whether respondents used home delivery services along with the booming of e-commerce in the recent decades; and whether these delivery services substituted their typical daily travel.

As discussed in Essay One, senior travelers will gradually need help on transportation access. It is important to understand seniors' preferences in terms of the sources of such travel

support: whether it is from neighbors/community centers (e.g., local YMCA/senior center shuttle services), public agencies (e.g., local transit agency), private services (e.g., taxi or Uber service), or family members/friends.

Existing literature also shows there have been new transportation options developed by various stakeholders *(Dize 2013; Freund 2013)*. However, many seniors either are not aware of these new options or do not trust these services. Therefore, this behavioral survey also asks respondents about their attitudes towards new transportation options. More specifically, my survey explores the likelihood of seniors trying/using new transportation options if the information about these options is disseminated by different stakeholders (e.g., community, public, private, or family members).

2.3.2. Survey implementation

Figure 2.1 shows the conceptual framework of my survey experiment. The web-based Qualtrics Survey Software[15] is utilized to create all the survey questions. Through advanced functions in Qualtrics, I am able to develop a survey questionnaire that, based on respondents' answers, automatically diverts them to different sets of survey questions for the three types of respondents discussed above. Then, the web-based survey questionnaire is pretested by two groups of people. The first group includes planning professors and my Ph.D. colleagues who know either the context of travel behavior analysis or the knowledge of survey techniques. I modify the survey questionnaire based on all of their critiques and suggestions. The second group includes my personal friends who have little or no knowledge about transportation planning and travel behavior survey. They mimic the survey respondents I will recruit through the Amazon MTurk, in terms of the knowledge about the survey contents. I also address the

[15] https://www.qualtrics.com/

questions and comments on my survey contents from the second group. With the finalized survey questionnaire, Qualtrics helps me to generate a survey link which is later embedded in my Amazon MTurk HIT workers recruitment post.

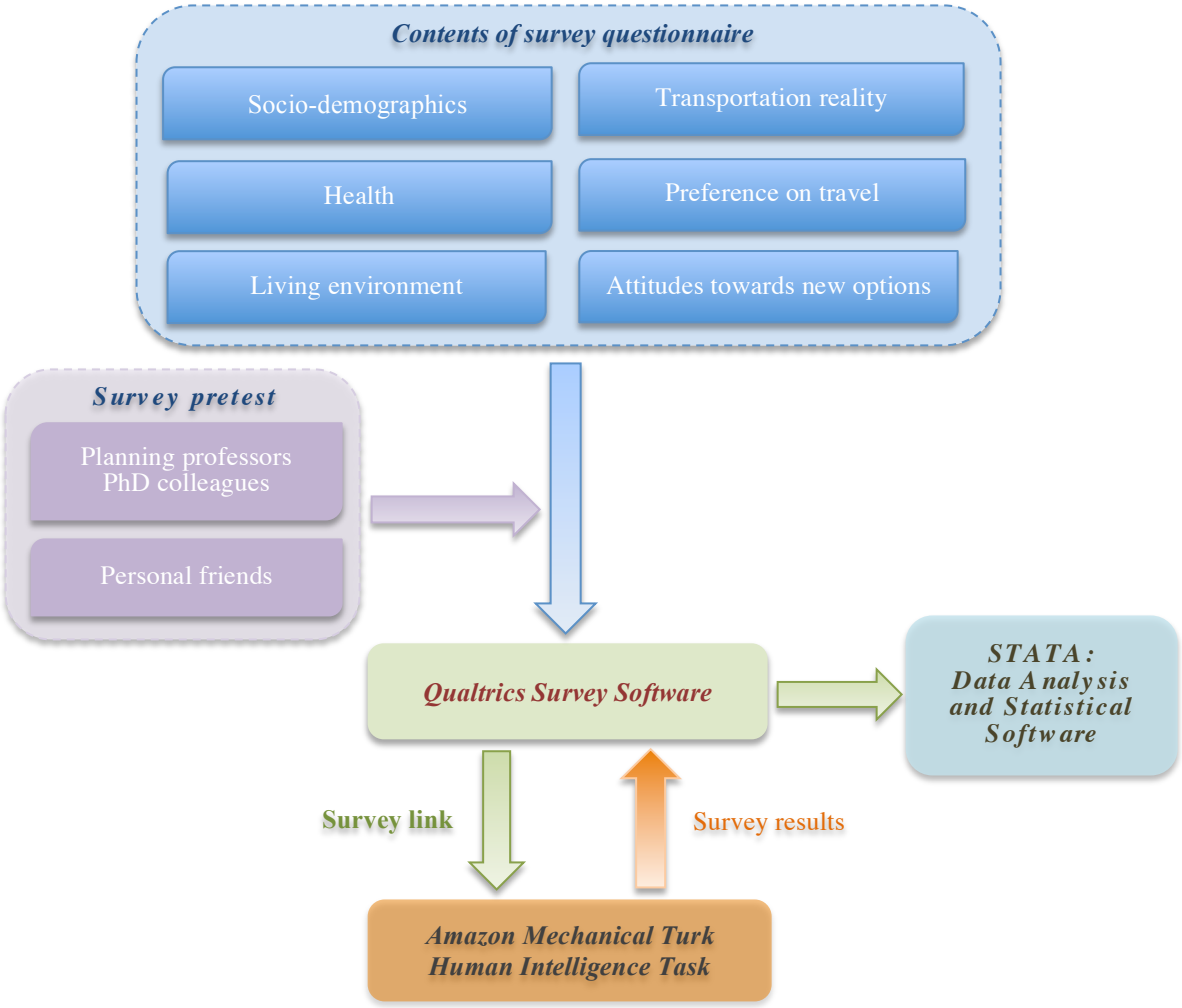
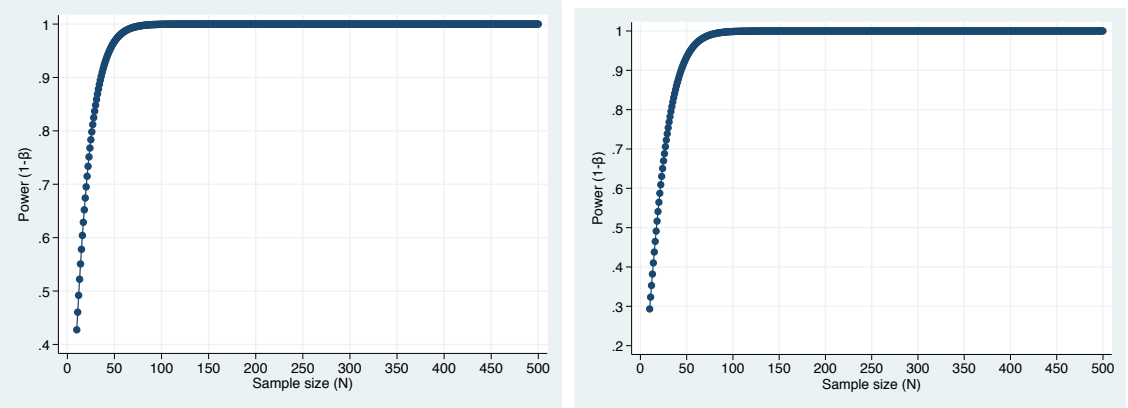


Figure 2.1. Conceptual framework of Amazon MTurk survey experiment

To determine the sample size, I conduct power analyses based on the one-sample mean test and the paired test comparing correlated means.[16] Following recommendations in the literature, I use a medium effect size (i.e., d = 0.5) in the power analyses *(Cohen 1988; Lipsey*

[16] These are tests that will be employed in Essay 3 for more comprehensive examinations of senior transportation options.

and Wilson 1993; Bausell and Li 2002). The effect size here is defined as the ratio between population mean difference and their common standard deviation. As shown in Figure 2.2, to achieve a power of 0.8, which is generally used by researchers *(UCLA IDRE n.d.)*, the minimum required sample size for my mean tests is thirty-four. As the survey cost on Amazon MTurk is relative low (more on this below) and I will also conduct subgroup analysis based on my full sample, I propose to use a relatively large sample size of five hundred, which should carry enough power to analyze my data sample.



a. one-sample mean test b. paired test comparing correlated means

Figure 2.2. Power analysis (power as a function of sample size)

The estimated time to complete the survey is about five (5) minutes. The survey respondent will be paid $0.75 once they finish all survey questions. The survey was launched on the Amazon MTurk platform in March 2016. Figure 2.3 displays a screenshot of my Amazon MTurk HIT. The survey is set to be posted on MTurk for approximately four weeks or when the number of respondents reaches five hundred, whichever comes first. During the actual survey distribution, it took less than one day to recruit all five hundred respondents. All the survey

results were returned and stored in Qualtrics and are later exported into the Data Analysis and Statistical Software – Stata[17] for further analysis.

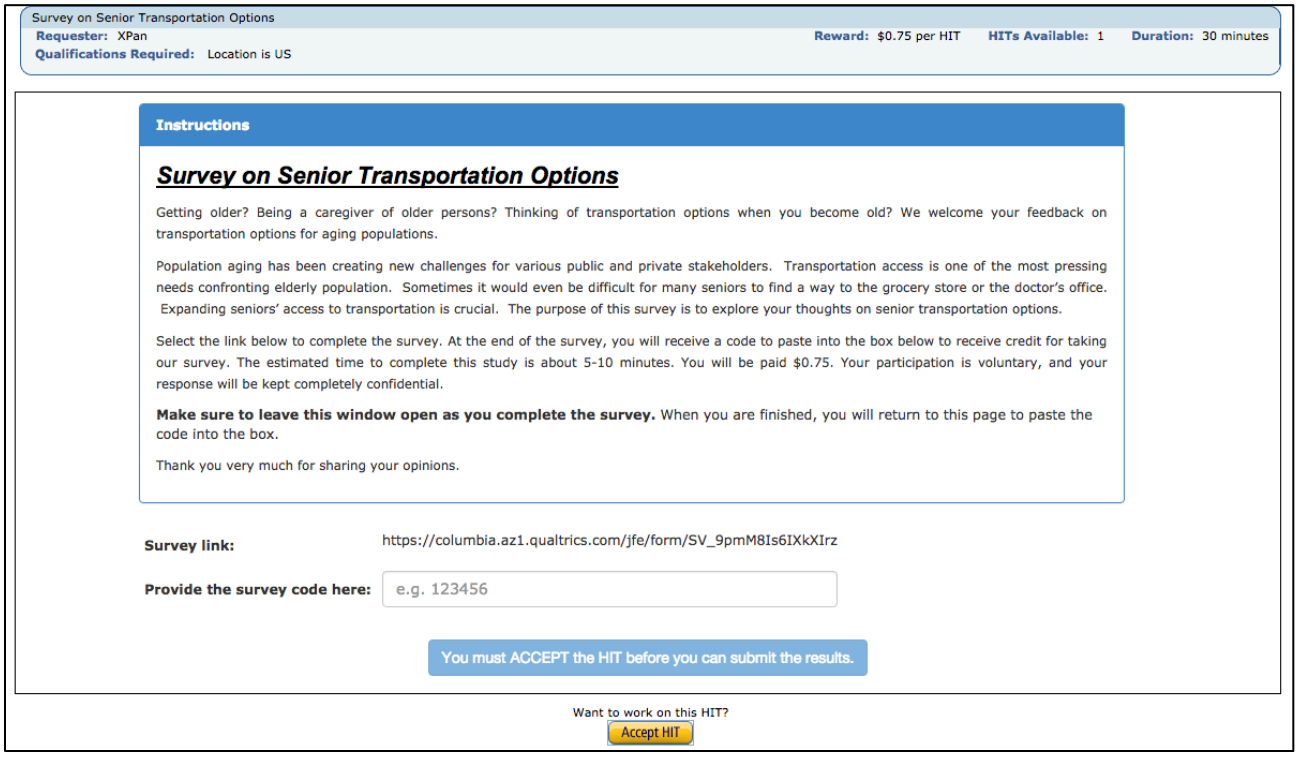


Figure 2.3. Screenshot of Amazon MTurk HIT (to recruit survey respondents)

In terms of survey implementation costs, Amazon generally charges 20 percent fee on the payment requesters pay to workers. For HITs with ten or more assignments, Amazon will charge an additional 20 percent fee. Since my questionnaire (i.e., HIT) contains more than ten survey questions (i.e., assignments), I need to pay 40 percent commission fee to Amazon. Therefore, the total cost for this survey is $525.00, including $375.00 ($0.75 × 500) paying to MTurk workers and $150.00 ($375.00 × 40%) paying to Amazon as a commission fee.

[17] http://www.stata.com/

2.4. Evaluating the Quality of Amazon MTurk Survey Data[18]

2.4.1. Data processing

All five hundred survey responses collected in the Qualtrics survey software are exported to Stata. The survey data are first screened, and obvious outliers are eliminated from further analysis. For instance, if the responding duration is less than 2.5 minutes, the corresponding observation is dropped from the further analysis. The final dataset contains four hundred seventy-five observations. Table 2.3 shows the frequency distribution of different respondent categories. Not surprisingly, a majority of survey respondents are younger than sixty-five years old; about 42 percent of them are caregivers of older adults. Importantly, the Amazon MTurk platform is able to catch twenty-eight senior respondents. Overall, this survey data represents a fairly diversified population.

Table 2.3. Frequency distribution of different respondent categories

Respondent category	Frequency	Percentage
Seniors	28	5.89%
Caregivers	189	39.79%
Non-caregivers	258	54.32%
Total	475	100.00%

2.4.2. Geolocations of survey respondents

Using an online geocoding tool, batchgeo[19], all ZIP codes reported by Amazon MTurk survey respondents are geocoded, and their geolocations are mapped, as shown in Figure 2.4. Geographically, the survey respondents are widely spread in the country: they come from many different states except for a few states in the mid-west and north-east.

[18] The main focuses of this essay (i.e., Essay Two) are to introduce the MTurk survey experiment and to explore the quality of MTurk survey data. The detailed analysis of aging Americans' travel behavior and travel preference will be presented in the next essay (i.e., Essay Three).

[19] https://batchgeo.com/

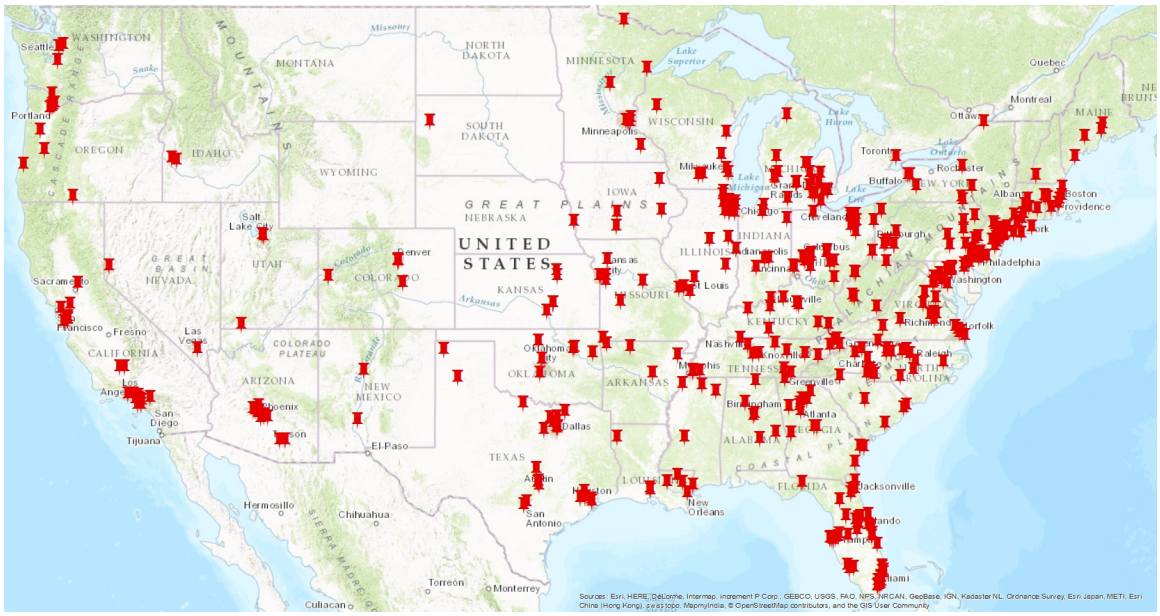


Figure 2.4. Geolocations of all Amazon MTurk survey respondents
(Source: (Deb et al. 2017))

2.4.3. Socio-demographic characteristics

Age

I compare the age distribution of respondents in the MTurk survey with those in the 2017 NHTS data (the most recent nationwide travel survey from the U.S. Department of Transportation) and the 2016 American Community Survey (ACS) estimates data (the most recent U.S. population data from the Census Bureau). As shown in Figure 2.5, the MTurk survey result contains a larger share of respondents who are between twenty-five and thirty-five years old, compared with 2017 NHTS and 2016 ACS estimates. As expected, the percentage of senior respondents is relatively low, possibly because the survey was distributed through a web-based platform and seniors may be less frequent users of the Internet than members of younger generations. These patterns are consistent with those identified in other researches using Amazon MTurks as well *(Paolacci, Chandler, and Ipeirotis 2010)*. Nonetheless, the MTurk survey

results, in general, are able to capture respondents from all age groups, and it shares a similar distribution pattern as the 2017 NHTS and 2016 ACS estimates except for a few age groups (i.e., the 25-34 age group and 75+ age groups).

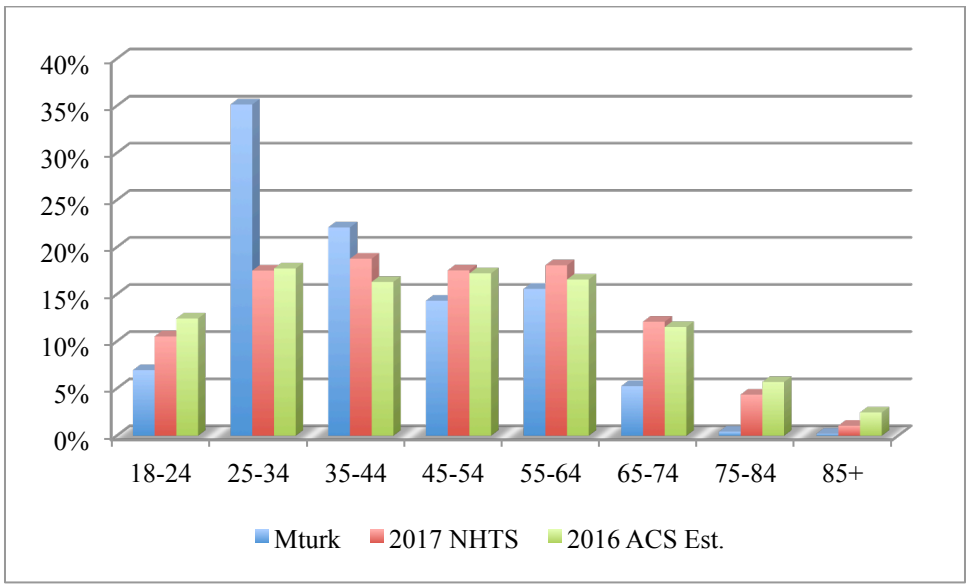


Figure 2.5. Age distribution and comparison with 2017 NHTS and 2016 Census
($n_{MTurk} = 475$; $n_{2017\ NHTS} = 827{,}555$)
(Source: U.S. Department of Transportation, 2017 National Household Travel Survey; U.S. Census Bureau, 2016 American Community Survey 1-Year Estimates)

Gender

There are more female respondents than male respondents in the MTurk survey, and this pattern holds for all three categories of survey respondents – Seniors, Caregivers, and Non-caregivers. The differences between two gender shares in all three categories of survey respondents are all greater than what was observed in the 2017 NHTS and the 2016 ACS estimates. Neither are these gender distribution differences consistent with the gender distribution observed in the typical MTurk worker population. Recent studies show there are no more gender gaps observed in the typical MTurk worker population; to some extent, there are more male workers than female *(The TurkPrime Team n.d.)*. Then, why are there more female

MTurk workers responding to the survey of senior transportation options? One potential explanation is self-section. Each MTurk worker can choose whichever HIT(s) he or she wants to participate in. It is possible women, and hence female MTurk workers, tend to pay more attention to such topics of senior transportation (and therefore agree to participate). In fact, by reviewing the detailed survey responses, I observe female respondents are more likely to leave specific comments and suggestions in the open-ended questions.

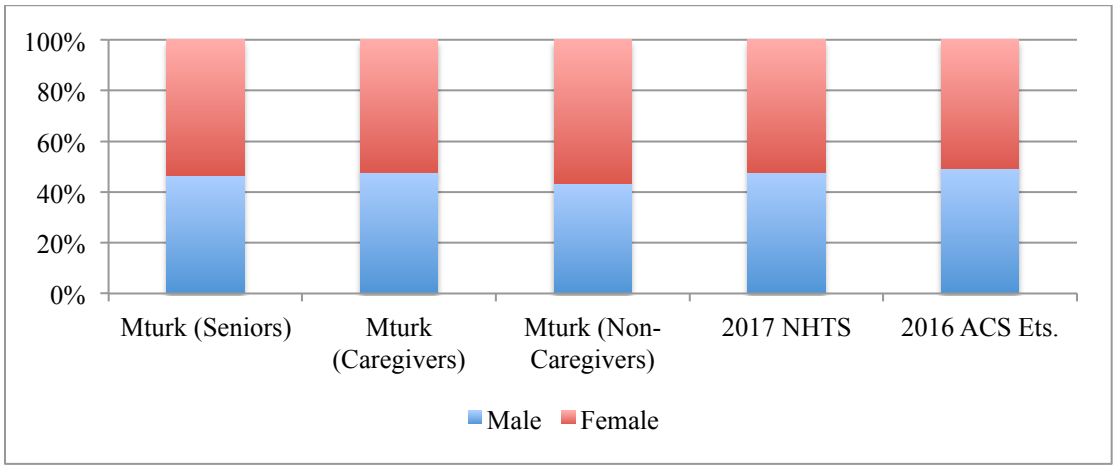


Figure 2.6. Gender distribution and comparison with 2017 NHTS and 2016 Census
($n_{\text{MTurk Seniors}} = 28$; $n_{\text{MTurk Caregivers}} = 189$; $n_{\text{MTurk Non-Caregivers}} = 258$; $n_{\text{2017 NHTS}} = 827{,}555$)
(Source: U.S. Department of Transportation, 2017 National Household Travel Survey; U.S. Census Bureau, 2016 American Community Survey 1-Year Estimates)

Income

Figure 2.7 shows the household income distribution of the Amazon MTurk survey respondents and compares it with that from the 2016 Census estimates. There are smaller percentages of respondents with high household incomes, compared with the current census survey estimates that represent the U.S. general population. More MTurk survey respondents belong to the categories of middle household income. These patterns are consistent with other studies that report MTurk workers' demographic *(Ipeirotis 2015)*. However, they may show seniors in both low-income and high-income households are under-represented in the survey

results based on this sample of Amazon MTurk respondents. Further focus group interviews and studies can be helpful to study seniors' travel preference in those under-represented income categories.

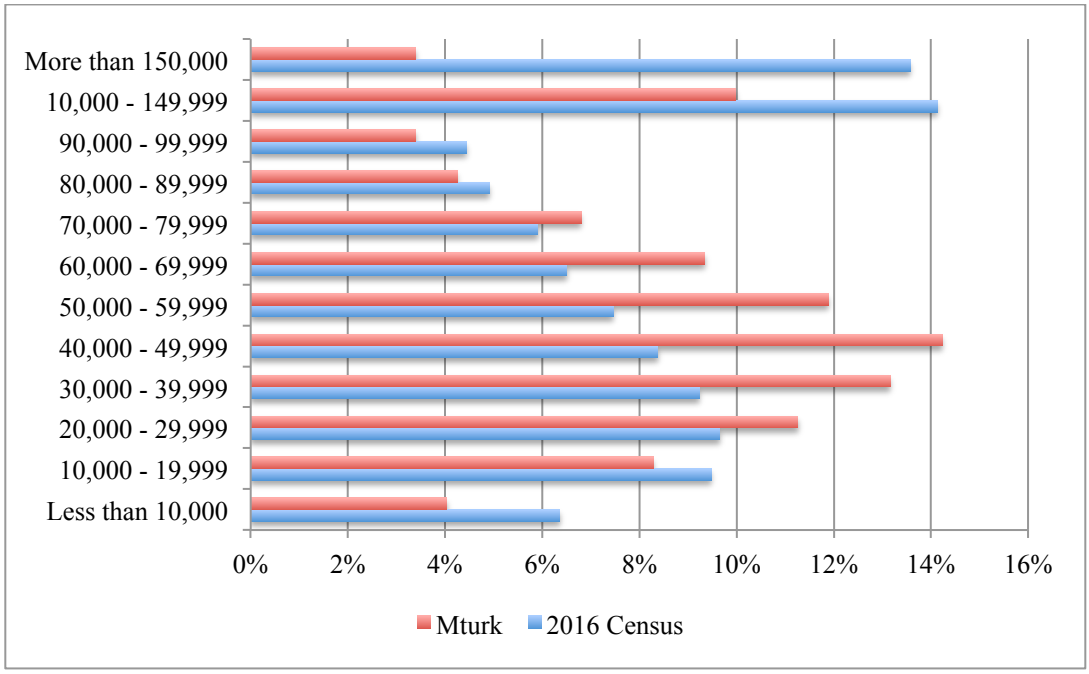


Figure 2.7. Income distribution and comparison with 2016 Census
($n_{MTurk} = 475$)
(Source: U.S. Census Bureau, Current Population Survey, 2017 Annual Social and Economic Supplement)

Education

As shown in Figure 2.8, more than 55 percent of MTurk survey respondents have either a bachelor's degree or postgraduate degree. That is significantly higher than its counterpart in the 2017 NHTS and 2017 current population survey estimates (i.e., 45% and 31% respectively). This finding of skewness towards higher education level is again consistent with the observations made in other behavioral researches utilizing the Amazon MTurk platform *(Paolacci, Chandler, and Ipeirotis 2010)*. This skewness may affect the representativeness of the survey results, which require attention in future transportation behavioral studies relying on Amazon MTurk workers or similar survey platforms.

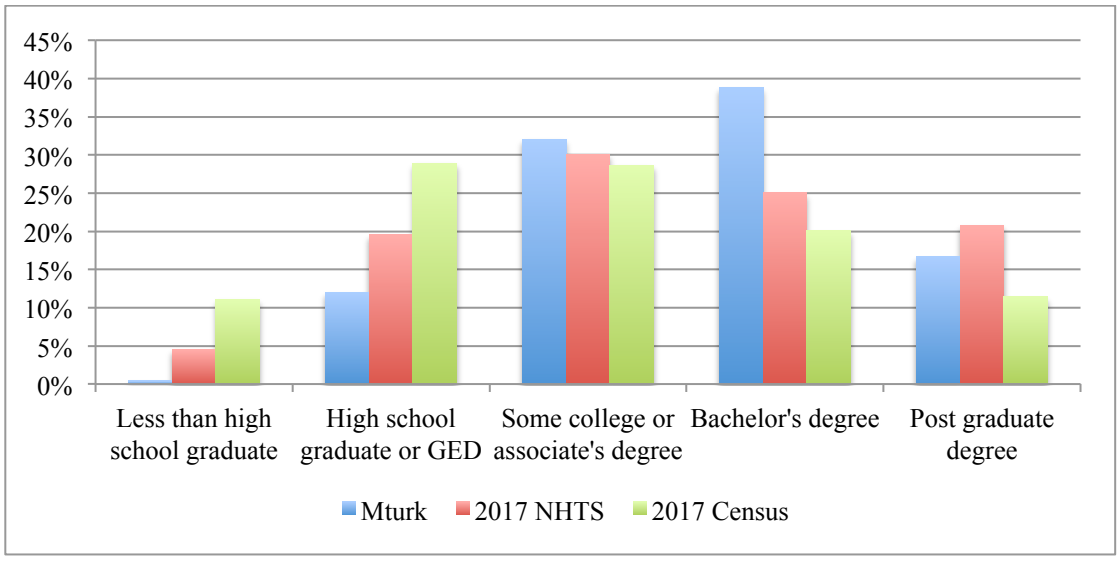


Figure 2.8. Education distribution and comparison with 2017 NHTS and 2017 Census
($n_{MTurk} = 475$; $n_{2017\ NHTS} = 827{,}555$)
(Source: U.S. Department of Transportation, 2017 National Household Travel Survey; U.S. Census Bureau, Current Population Survey, 2017 Annual Social and Economic Supplement)

2.4.4.Transportation features

Travel distance

Respondents' daily travel features related to shopping, health care, and recreation or social activities are collected in the MTurk survey. I do not gather travel characteristics about commuter trips in my survey questionnaire because along with the aging process, seniors' major travel needs gradually shift from commuting to other daily travels, such as shopping, health care, and recreation or social activities. The distribution of travel distance for these daily travels is shown in Figure 2.9, and it is compared with that from the 2017 NHTS. Most respondents in MTurk survey travel 1/2 to 10 miles for trips related to their daily needs; a similar pattern is observed in the 2017 NHTS. MTurk survey respondents report slightly higher shares for this mid-range travel distance. In particular, 84%, 80%, and 82% MTurk survey respondents travel one-half to ten miles for trips related to shopping, health care, and social activities, respectively. In contrast, only a few respondents from either MTurk survey or the 2017 NHTS travel less than

one-half mile for their daily needs, which generally represents a comfortable walking distance. This implies most of the trips related to daily needs are not via walking. In addition, healthcare related trips tend to have longer travel distance than other trips for both MTurk survey and the 2017 NHTS respondents. For instance, only 3% of MTurk survey respondents and 5% of 2009 NHTS respondents can travel less than one-half mile for their healthcare needs; while the shares of healthcare travel that are greater than ten miles for these two surveys are 18% and 30%, respectively. Overall, as shown in Figure 2.9, the travel distance distribution of MTurk survey results follows the general distribution pattern of the 2017 NHTS data across all specific travel purposes, i.e., shopping trips, health care trips, and recreation or social trips.

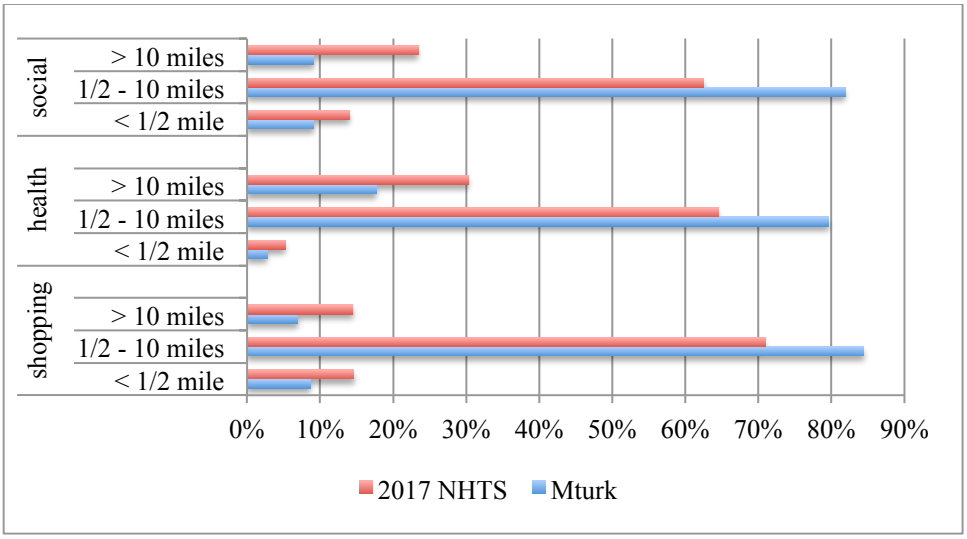


Figure 2.9. Travel distance distribution and comparison with 2017 NHTS
($n_{MTurk} = 475$; $n_{2017\ NHTS} = 373{,}175$)
(Source: U.S. Department of Transportation, 2017 National Household Travel Survey)

Travel mode

Another transportation feature collected in the MTurk survey, travel mode, is analyzed and compared with the 2017 NHTS data. Since my survey focuses on seniors' transportation options, it has a slightly different categorization of travel modes than the 2017 NHTS, which targets the general population's travel characteristics. Therefore, due to the differences in survey

questionnaire design between my MTurk survey and the 2017 NHTS, I analyze a selected set of travel modes here. Similar to the travel distance analysis above, the travel mode analysis and comparison are controlled for trips related to respondents' different daily needs, i.e., shopping trips, health care trips, and recreation or social trips. As Figure 2.10 shown, the most popular travel mode used by both MTurk survey and the 2017 NHTS respondents is private vehicle, i.e., 86% and 84%, respectively. In contrast, there are only 5% MTurk survey respondents and 12% NHTS respondents walk for their daily needs; the share of using public transits (train and bus) is even lower, 3% and 2%, respectively. These numbers appear to be consistent with the travel distance analysis above in that most trips taken by the respondents in both surveys are longer than half a mile, which is beyond a comfortable walking distance. Again, the overall travel mode distribution of MTurk survey seems to follow the general pattern of the 2017 NHTS data, suggesting MTurk could be a valuable crowdsourcing platform for conducting transportation or planning surveys and experiments.

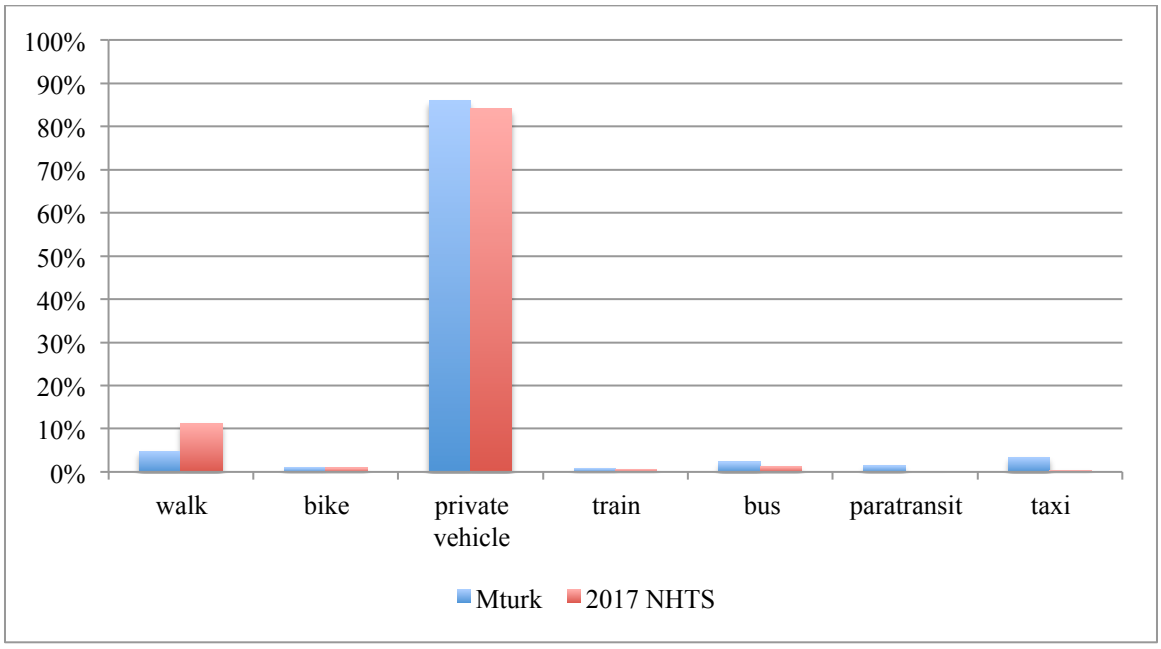


Figure 2.10. Travel mode comparison with 2017 NHTS
($n_{MTurk} = 475$; $n_{2017\ NHTS} = 373{,}521$)
(Source: U.S. Department of Transportation, 2017 National Household Travel Survey)

2.5. Summary and Future Work

Surveys have been used extensively in transportation researches and practices. Since the 1930s, state and federal transportation agencies have started using surveys to understand Americans' daily travel pattern in order to support planning, to update policies, and to improve services. Most nationwide and regional travel surveys conduct in-person interviews, telephone interviews, or self-administered survey questionnaires distributed by mail. However, many of these survey methods are quite costly and time-consuming. The prior literature also shows many travel surveys conducted by transportation researchers and practitioners tend to have a wide range of objectives and use a variety of survey methods. With the fast demographic change towards population aging, seniors' travel preferences need to be addressed in a timely manner. Meanwhile, rapid technological innovations and new business models offer researchers and practitioners unique channels in the crowdsourcing age to conduct behavioral studies. My survey of aging Americans' travel behavior is certainly a compelling pilot experiment utilizing the innovative Amazon MTurk platform.

The MTurk survey results indicate the MTurk platform is able to capture three categories of respondents that represent 1) seniors; 2) younger generations who are caregivers of an elderly dependent; 3) younger generations who are not caregivers. Geographically, survey respondents from the MTurk crowdsourcing platform are widely spread across different states. Compared with the most recent NHTS and census, the MTurk survey data contain more younger respondents, slightly more female respondents than male respondents, fewer respondents' with household income falling into either low-income or high-income categories, and more respondents who attained higher education, such as a bachelor's degree and postgraduate degree.

Overall, the Amazon MTurk survey data represent a fairly diversified population. Further comparisons also confirm the distribution of transportation features collected via MTurk survey, e.g., travel distance and travel mode, follows the distribution pattern of the 2017 NHTS data. In general, the MTurk survey is able to catch respondents from different socio-demographic categories, and its respondents share a similar distribution pattern as those observed in the general population data (i.e., Census) and the large-scale nationwide transportation survey data using random sampling methods (i.e., NHTS).

As one of the first pilot experiments testing a crowdsourcing platform for conducting travel behavioral research, my survey has the following limitations that motivate several directions for future studies. First, similar to other studies using convenience samples, there may exist self-selection bias in the survey results. Second, without a proper weighting mechanism, MTurk results may over-represent or under-represent groups of respondents with certain socio-demographic characters. Nonetheless, this study demonstrates to planners and decision-makers that, together with many other innovative online data collecting tools, Amazon MTurk could be a valuable crowdsourcing platform for conducting planning-related surveys, experiments, and data collections in an economical and timely manner.

Essay Three: Exploring Aging Americans' Travel Preferences and Options: Analysis of the Experimental Amazon Mechanical Turk Survey

Abstract

While there is a consensus among transportation practitioners and researchers on the challenges posed by the rapidly aging population, we know relatively little about how to increase seniors' awareness of available transportation support and how to encourage seniors to use existing and new transportation options. By analyzing my Amazon MTurk survey data, this essay investigates these issues. First, the users of senior transportation services are not limited to seniors themselves. Thus, my survey examines different types of users of senior transportation services including seniors, caregivers and their elderly dependents, as well as younger travelers. Results show similarities as well as disparities in transportation features, preferences, and attitudes among different respondent groups. Second, for aging boomers, travel is often beyond the simple description of origins and destinations; it is a symbol of independence and is a critical factor for quality of life. Therefore, instead of the traditional utility-based mode choice models, my study attempts to incorporate behavioral factors derived from the Theory of Planned Behavior (TPB) to explain seniors' travel mode choices. While respondents from different user groups value behavioral factors quite differently in their travel mode choices, attitude factors (e.g., convenience, preference, and independence) in general are perceived as more important drivers for respondents' mode choices than other aspects of TPB (e.g., social norm, feasibility, and cost). This indicates more attention should be paid to attitude factors, rather than the traditional concerns such as feasibility and cost when designing and implementing interventions for senior transportation services. In addition, my study explores respondents' preferences on the

types of senior transportation support, as well as respondents' preferable channels from which they want to receive information about new senior transportation options. Results show respondents from all different groups value transportation support provided by family members and friends the most, suggesting promoting family- and friend-like senior transportation support could gain more trust and attract more users. It is also encouraging to find respondents across all three groups value all types of information channels and that they are willing to try senior transportation options promoted via these channels.

Keywords: Population Aging, Senior Transportation, Travel Behavior, Theory of Planned Behavior (TPB), Survey, Amazon Mechanical Turk (MTurk)

3.1. Introduction

The baby boomer generation, who has created the most dramatic changes in the age structure of the U.S. population in the past century, has been turning sixty-five since 2011. There is a consensus among transportation practitioners and researchers on the challenges posed by the rapidly aging population. Many existing senior transportation options often focus only on (current) seniors' (own) travel needs. However, the users of senior transportation services, i.e., those who choose to use and pay for these services, do not limit to seniors themselves and can come from a much broader population. By designing and implementing a comprehensive behavioral survey via Amazon MTurk platform, I examine different types of users of senior transportation services including seniors themselves, caregivers and their elderly dependents, as well as younger travelers (who will become the future users of these services). Such a user group categorization can help planners and service providers gather more comprehensive information

about senior and elderly dependent groups' current transportation needs, about transportation challenges faced by the caregiver group, and about perspectives from the younger group on future senior transportation options.

For aging boomers, travel is often beyond the simple description of origins and destinations; it is a symbol of independence and is a critical factor for quality of life. However, there is limited literature that examines such behavioral aspects in seniors' travel mode choices. From a psychological behavior perspective, my study attempts to incorporate different aspects of the Theory of Planned Behavior (TPB) to explain seniors' travel mode choices. More specifically, my Amazon MTurk survey investigates behavioral factors related to the most used travel mode among three types of survey respondents (i.e., seniors, caregivers of seniors, and younger people). These factors include convenience, preference, independence, social norm, feasibility, and cost. They respectively represent three drivers for one's behavioral change in the TPB: "attitudes," "subjective norm," and "perceived behavioral control."

Although there are more senior transportation options available today, we know relatively little about how to increase seniors' awareness of these available transportation options and how to encourage seniors to use existing and new options. By analyzing the Amazon MTurk survey data, this essay also explores respondents' preferences on types of senior transportation support, including support from neighbors, community centers, public agencies, private services, or family members and friends. Then, this essay also analyzes respondents' preferable channels from which they want to receive information about senior transportation options.

The remainder of this essay is organized as follows. In section 3.2, I explore factors affecting seniors' travel mode choices; in particular, I introduce behavioral factors based on the TPB for analyzing seniors' travel mode choices. I also discuss different users of senior

transportation services, as well as innovative practices of senior transportation options. In section 3.3, I articulate my research questions, survey data, and analytical methods. In section 3.4, I analyze my survey data and interpret my findings. In section 3.5, I summarize my behavioral survey study of senior transportation options and discuss limitations and potential future research directions.

3.2. Literature Review

3.2.1. Factors of seniors' travel mode choices

A range of travel behavior theories seeks to explain individuals' travel mode choice. Many current travel behavior researches have drawn primarily on the demand theory, which uses the utility maximizing framework with an engineering-oriented utility maximization model to optimize utility (e.g., how quickly or inexpensively one can travel from origin to destination with a particular travel mode) *(National Research Council (US) 2005)*. However, seniors often view travel beyond the simple scope of travel time, distance, or cost; instead, they consider travel as a self-image issue and as an essential component of their independence of life. Adapting a behavioral theory from the psychology perspective may provide a better and more complete explanation of seniors' travel mode choices. A clear understanding of the drivers of seniors' travel mode choices allows us to identify effective strategies to improve seniors' transportation experience now and in the future. My study attempts to incorporate the Theory of Planned Behavior (TPB) in the behavioral survey design and analysis.

Theory of Planned Behavior explains behavior as the interplay among attitude towards the behavior, subjective social norm, and perceived behavioral control *(Godin and Kok 1996)*. These factors are believed to be three drivers for one's behavioral change. "Attitude towards the

behavior (Act) is an expression of one's positive or negative evaluation of performing a given behavior" *(Godin and Kok 1996, page 88)*. In my survey, I evaluate respondents' "attitude" factors, by asking them what factors lead them to their current most frequently used travel mode: convenience, personal preference, or independence of life. "The perceived subjective social norm (SN) reflects personal perception of the social expectations to adopt a given behavior" *(Godin and Kok 1996, page 88)*. My questionnaire surveys the "social norm" factor by asking whether the respondents pick the most frequently used travel mode is because their friends and neighbors use the same travel option. "Perceived behavioral control (PBC) reflects personal beliefs as to how easy or difficult performing the behavior is likely to be" *(Godin and Kok 1996, page 88)*. Personal beliefs may depend on both external factors (e.g., availability of time or money, social support) as well as internal factors (e.g., ability, skill, information). The "perceived control" factors collected in my study include feasibility and cost of the most frequently used travel mode.

Theory of Planned Behavior has been applied in many research fields, such as consumer behavior, energy saving, environmental protection, and health behavior *(Pookulangara, Hawley, and Xiao 2011; Tan, Ooi, and Goh 2017; Oztekin et al. 2017; L. T. Lee et al. 2017; Mancha and Yoder 2015)*. Factors proposed in the TPB have been approved to be significant predictors of people's behavioral change. A range of transportation-related studies has also used TPB to explain travelers' behaviors *(Potard et al. 2018; J. Y. Pan and Truong 2018; Jiang et al. 2017; Frater, Kuijer, and Kingham 2017; Barton, Kologi, and Siron 2016; Thorhauge, Haustein, and Cherchi 2016; Li et al. 2016; Zhou, Romero, and Qin 2016; Warner and Åberg 2006)*.

Many transportation-related studies employ the TPB to explain different types of travelers' behaviors and choices. For instance, using data collected from 112 drivers, researchers found attitude towards speeding, subjective norm, and perceived behavioral control were

significant determinants of self-reported speeding *(Warner and Åberg 2006)*. Using the TPB factors to explain risk-taking behaviors among cyclists, researchers found TPB factors explained 49% of the variance in the intention to run the red light and 65% of the variance in the intention to turn left in intersections *(Cristea and Gheorghiu 2016)*. Based on a survey of eighty adults, researchers found attitude and perceived behavioral control predicted intentions to cross streets while distracted *(Barton, Kologi, and Siron 2016)*. In order to reduce peak-hour congestion, researchers added psychological factors that derived from the TPB in their (flexible) departure time choice analysis and found all included TPB factors had a significant effect on departure time choices *(Thorhauge, Haustein, and Cherchi 2016)*.

As discussed above, behavioral factors may play a more important role than traditional utility-based factors when seniors make their travel choices. However, we know relatively little about what behavioral factors drive seniors' travel mode choices. In particular, no prior literature, to the best of my knowledge, has conducted a structured study on the impact of different behavioral factors on seniors' travel behavior. My MTurk survey study intends to fill in such an important literature gap. Specifically, I will use TPB as a theoretical framework to investigate whether behavioral factors related to attitude, social norm, and perceived behavioral control can explain seniors' travel mode choices, and if so, how these factors play a role.

3.2.2. Senior transportation options: users and innovations

Users of senior transportation services

When thinking about the customers of senior transportation services, one often only focuses on (current) seniors' (own) travel needs. However, customers of senior transportation services can come from a much wider population. For instance, caregivers often need to arrange

transportation services for their elderly dependents. In this case, though the caregivers do not consume the service directly, they are de facto the customers who ultimately choose and arrange the service. It would be valuable to explore perspectives towards senior transportation services from these different types of users.

Through a comprehensive design of the behavioral survey questionnaire, I am able to incorporate three types of survey respondents in my study, i.e., 1) seniors, 2) caregivers and their elderly dependents, and 3) younger people. Seniors represent the existing customers who order and use the senior transportation services themselves now. For the first group of survey respondents, I ask them directly in the survey questionnaire about their living environment, transportation reality, preferences on transportation options, and attitudes towards new transportation options.

Elderly dependents are also existing users of senior transportation services who, however, rely on their caregivers to arrange or to order different sources of senior transportation support. Even if caregivers do not directly provide or order transportation services for their elderly dependents, opinions of caregivers play an influential role in determining what type of transportation services their elderly dependents would get, possible via shared decision-making. Furthermore, caregivers often face great challenges as they help their elderly dependents with driving retirement and arrange senior transportation services for their elderly dependents *(Frost-Steward 2015; St Louis et al. 2011)*. Opinions and preferences from those who assist seniors in arranging transportation services (i.e., caregivers) are important to service planners, designers, providers, and operators. Therefore, for second user group, I survey respondents who are caregivers of elderly dependents and ask caregivers about challenges they facing to arrange transportation support for their elderly dependents, their elderly dependents' living environment,

their elderly dependents' transportation reality, their elderly dependents' preferences on transportation options, and their elderly dependents' attitudes towards new transportation options. For ease of discussion, I may use short phrases, such as "elderly dependents (group)" and "elderly dependents' attributes" instead of writing the full phrases, such as "caregivers and their elderly dependents (group)" and "elderly dependents' attributes reported by their caregivers."

Younger people are also potential future customers of senior transportation services, and their input will benefit the planning of future senior transportation options. In my survey study, I ask the third group of respondents about their current transportation reality and their preferences and attitudes towards future senior transportation options.

Innovative senior transportation options

A significant amount of effort has been spent over the years to help seniors with their transportation needs, especially after they cease driving. In addition to the traditional public transit services, a variety of innovative senior transportation options have been developed by different sources. Some of them are initiated by public transportation agencies; some of them are community-based services; some of them are promoted by private companies. I discuss a few cases below as illustrative examples.

As an effort of the Safe Mobility for Life Coalition, Florida's "United We Guide Project" brings together an alliance of aging, health, and transportation agencies, as well as academic research entities and private sectors.[20] In the pilot stage, the project trained the existing Community Transportation Coordinators to become Mobility Managers; it also developed a "one-call" system—a single telephone number to call for information about transportation

[20] http://www.safeandmobileseniors.org/FloridaCoalition.htm

options, safety, and mobility. The project aims to provide older adults assistance with the access to a ride where and when they need to go; moreover, the collected information from the one-call system can be used to identify service gaps *(Dize 2013)*.[21]

Another non-profit agency in Florida serving older adults is ElderPoint Ministries, which services the senior population of Lakeland, Florida and its surrounding areas. The organization "provides a continuum of free home-based services to support healthy, safe and independent living for our older adult neighbors through interfaith volunteers."[22] Through their Bluebird Mobility Network, volunteer drivers help seniors without transportation to get where they need to go at *no cost*. ElderPoint Ministries volunteers have provided thousands of free rides to transport seniors to the grocery store, doctor's office, social activities, or family member's house.[23]

TimeBanking, an innovative concept of service-exchange using time as currency[24], has been a successful practice adopted by many communities.[25] Senior transportation stakeholders and providers can develop a partnership with established timebanks to incorporate riding older people as one type of service exchanges. An example of such partnership is the coordination project of the Dane County (Wisconsin) Department of Human Services, TimeBank, and health care centers. By providing an alternative service in exchange, patients who had difficulty arranging transportation can receive rides from others for their health care appointments *(Dize 2013)*. The program has been successful in reducing the number of missed health appointments, which is expected to improve the patient outcome and to save cost for both individuals and the health care system.

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21 https://www.gpo.gov/fdsys/pkg/CHRG-113shrg25451/pdf/CHRG-113shrg25451.pdf
22 http://elderpoint.org/
23 http://elderpoint.org/services/bluebird-transit
24 One hour helping another earns one TimeBank Hour (also called time credits, service credits or time dollars).
25 http://timebanks.org/

Pelivan Transit in Northeast Oklahoma is also an interesting case. Since 1985, Pelivan Transit has been providing flexible, accessible transportation to a rural, seven-county area in northeastern Oklahoma.[26] The sustainability of this program is benefited from its diverse funding streams, "including Federal Transit Administration, Older Americans Act, service contracts with state and local governments, the Medicaid Non-Emergency Medical Transportation Program, nonprofit foundations, for-profit businesses and advertising revenues *(Dize 2013)*." In addition, the service provider closely coordinates with human services, which notably improves the service efficiency and quality.

Another appealing example is ITNAmerica who claims itself as "the first and only national non-profit transportation service for America's aging population *(Freund 2013, page 2)*." Using a series of innovative business models and a combination of paid and volunteer drivers, ITNAmerica provides automobile rides twenty-four hours a day, seven days a week for seniors and people with visual impairments. Through the Personal Transportation Account™, riders may trade the cars they no longer drive to pay for their rides, and they spend an average round-way fare of about eleven dollars. By volunteering to drive others, drivers may save transportation credits that can be used for their own future needs, transferred to their loved ones, or donated to low-income riders. ITNAmerica also welcomes the partnership with local businesses, such as restaurants or health care centers, which may help pay for rides to bring more senior customers. The service provider believes Independent Transportation Network (ITN), a type of consumer-oriented transportation, "can effectively replace for older people the level of mobility provided by driving an automobile, possibly easing the transition from the driver's seat to the passenger seat *(Freund 2013, page 6)*."

[26] http://www.seniortransportation.net/ResourcesPublications/SuccessStoryGrandGateway.aspx

The new private on-demand transportation companies, such as Uber and Lyft, have also been promoting their specialized services for seniors (and people with disabilities). For instance, uberASSIST allows users to select vehicle options that can accommodate folding wheelchairs, walkers, and collapsible scooters. And uberASSIST drivers are trained and educated to handle passengers with disability and mobility challenges.[27] Lyft has also been partnering with senior care communities, nonprofit groups, and home care providers to provide efficient and affordable transportation options for older adults and senior care providers.[28] Although Uber and Lyft on-demand transportation services usually rely on its smartphone app, seniors do not necessarily need a smartphone in order to use the Uber and Lyft transportation service.[29,30] For instance, through the newly developed function, a family member or a friend with the smartphone Uber app can easily and seamlessly request a ride on behalf of a senior without a smartphone. Uber will then send the senior rider a text message with the vehicle information and the driver's phone number so they can communicate directly.[31] Another way Uber and Lyft assist senior riders is through their "Uber Central" or "Lyft Concierge," where organizations or businesses serving senior population can easily provide on-demand, door-to-door transportation for their senior customers.[32] For instance, a nonprofit organization or company, such as Common Courtesy[33] and GoGoGrandparent[34] is able to use Uber Central or Lyft Concierge to help seniors who do not own a smartphone to schedule one-off or recurring Uber or Lyft rides.

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[27] https://www.uber.com/en-SG/drive/resources/uberassist/
[28] https://blog.lyft.com/posts/new-solutions-to-keep-seniors-moving
[29] https://www.uber.com/community/economic-opportunities/seniors/
[30] https://blog.lyft.com/posts/new-solutions-to-keep-seniors-moving
[31] https://www.uber.com/newsroom/lovedone/
[32] https://www.uber.com/newsroom/u4b-central/
[33] https://www.commoncourtesyrides.org/
[34] https://gogograndparent.com/

As shown by the above examples, there seems to be quite a range of transportation options available to seniors. Besides transportation support received from family members and friends, the sources of either traditional or innovative senior transportation options come from different public agencies, community entities, as well as private companies. However, the literature that examines whether seniors, caregivers, and future seniors prefer certain types of sources of senior transportation options is limited. In addition, though there may exist a range of senior transportation options, we have limited knowledge about what communication channels that seniors prefer to receive information from, so as to increase the usage of these transportation options. One important goal of my survey design is to fill up these critical knowledge gaps. By discovering preferences on the sources of senior transportation support and attitudes on communication channels to receive information on senior transportation options, I hope to provide valuable insights to help transportation planners and service providers design and market their senior transportation options. Ultimately, seniors (including caregivers) may increase their awareness of the existing and new transportation options that are available and then make an informed choice among these options.

3.3. Research Questions, Data, and Analytical Methods

Based on the above literature review, I propose to address three research questions in my study. 1) Are there any disparities in the consumption pattern of senior transportation services among different user groups, i.e., seniors, caregivers and their elderly dependents, and younger people? 2) Which behavioral factor(s) derived from the TPB are perceived as important ones that affect seniors' travel mode choices? 3) Which sources of senior transportation support are perceived as preferable ones and which information channels are perceived as credible and

preferred ones? A positive answer to research question 1 could confirm it is meaningful and valuable to explore perspectives towards senior transportation services among different types of users. By answering research question 2, I hope to identify behavioral factors that are more suitable for studying and understanding seniors' travel mode choices than the traditional utility-based factors. Findings on research question 3 could help planners and services providers to design more feasible and attractive senior transportation interventions and to market them through effective information channels.

To answer these research questions, I design a comprehensive survey questionnaire and implement it through the innovative Amazon Mechanical Turk (MTurk) platform. For detailed information about the MTurk survey design and implementation, please refer to Essay Two. The sample size of the MTurk survey is set to five hundred, which, according to the detailed power analysis in Essay Two, should carry enough power in the statistical analysis. All survey responses are exported into the data analysis and statistical software Stata[35] for analysis. After screening and removing outliers[36], the final dataset contains 475 observations. It includes all three different respondent groups, i.e., seniors (n=28), caregivers and their elderly respondents (n=189), and younger people (n=258).

In terms of data analysis, descriptive statistics are first utilized to illustrate features such as living environment, transportation reality, and most frequently used travel option. Similarities and disparities are explored among different groups of survey respondents, i.e., seniors, caregivers and their elderly dependents, and younger people. Then, inferential statistics are used to examine behavioral questions such as behavioral factors affecting travel mode choices, preferences on sources of senior transportation support, and attitudes towards information

[35] http://www.stata.com/

[36] The survey data are screened and obvious outliers are eliminated from further analysis. For instance, if the responding duration is less than 2.5 minutes, the corresponding observation is dropped from the further analysis.

channels of senior transportation options. Note that a seven-point agree-disagree Likert scale (1: strongly disagree, 2: disagree, 3: somewhat disagree, 4: neither disagree nor agree, 5: somewhat agree, 6: agree, and 7: strongly agree) is used for behavioral questions. Following the practices in the literature on behavioral research, this 7-point Likert scale is treated as a continuous variable in my analysis. In the analysis, the average Likert score of each behavioral question is first calculated; then, the t-test is used to check whether this mean is statistically greater than the neutral point 4.0. A statistically significant result indicates the corresponding behavioral factor, preference, or attitude is considered as an important one perceived by the survey respondents. In addition, repeated measures ANOVA analysis is used to conduct further pairwise comparisons of factor, preference, or attitude scores so as to discover similarities and disparities in the importance ranking of each factor, preference, and attitude among different respondent groups. I used a repeated measures ANOVA (also called within-subjects ANOVA) method here to deal with correlation in the repeated samples in my data.

3.4. Findings and Discussion

This section presents detailed findings and discussion of my Amazon MTurk survey. Survey results are either illustrated by descriptive statistics or interpreted by inferential statistics. They are organized by different sub-topics below, including living environment, transportation reality, most frequently used travel option, behavioral factors affecting travel mode choices, preferences on sources of senior transportation support, and attitudes towards information channels of senior transportation options.

3.4.1. Living environment

Density, housing, and household demographics

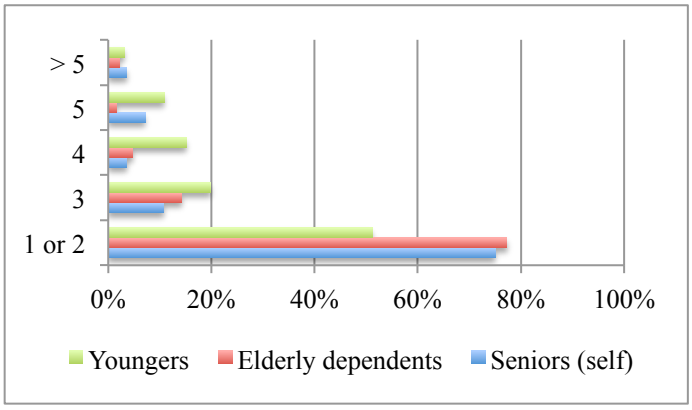
As shown in Table 3.1, a similar distribution of living environment density is discovered among different respondent groups, i.e., seniors, elderly dependents[37], and younger people. A majority of respondents live in suburban areas—about one-fifth of respondents live in urban areas, and the remaining respondents live in rural areas. In terms of housing features, about three-quarters of elderly dependents and younger respondents live in houses. Seniors seem to have a slightly lower share of living in houses than the other two groups of survey respondents; however, a majority of seniors selecting the "other" option state in the open-ended answer that their housing type is a condominium or duplex (house). Table 3.1 also presents the share of respondents who own or rent their homes: 75% seniors and 77% elderly dependents report they own their house or apartment while young respondents have a lower share of ownership (60%) and a higher share of renting (40%) houses or apartments. For household demographics, a majority of senior households (including elderly dependents) have one or two household members, and most of these members are also seniors (shown in Figure 3.1). All the results above affirm that addressing senior transportation needs would be challenging, since most seniors, including elderly dependents, live in their own housing properties with household members who are also seniors at low-density areas with limited existing public and private transportation options.

[37] As mentioned before, to facilitate the analysis and discussion, I may use short phrases, such as "elderly dependents (group)" and "elderly dependents' attributes" instead of writing the full phrases, such as "caregivers and their elderly dependents (group)" and "elderly dependents' attributes reported by their caregivers". For instance, here, attributes about elderly dependents' living environment were reported by their caregivers.

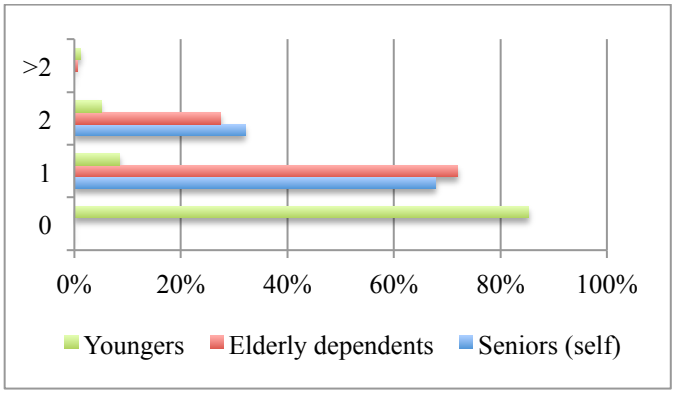
Table 3.1. Distribution of density and housing features

Features	Seniors (self)	Elderly dependents	Younger people
Density			
Urban	21%	25%	22%
Suburban	**56%**	**57%**	**59%**
Rural	22%	18%	19%
Housing type			
House	**64%**	**77%**	**73%**
Apartment	14%	20%	22%
Other	21%	3%	5%
Owned or rented			
Owned	**75%**	**77%**	**60%**
Rented	25%	23%	40%

Note: $n_{Seniors}$=28; $n_{Caregivers\ and\ their\ elderly\ respondents}$=189; $n_{Younger\ people}$=258



a. Household size



b. Number of seniors in a household

Figure 3.1. Household demographics

($n_{Seniors}$=28; $n_{Caregivers\ and\ their\ elderly\ respondents}$=189; $n_{Younger\ people}$=258)

Aging in place

My MTurk survey results echo the findings in most of the aging literature in that a majority of aging Americans prefer aging in place. In my data, about 80 percent of senior respondents claim they plan to live in their home as long as they can (see Figure 3.2). Even more elderly dependents (94%) plan to age in place for as long as they can. This large number of seniors with a strong preference for aging in place has brought significant challenges to different stakeholders. For instance, they need convenient shopping and dining services, sufficient and accessible health care services, adequate recreational activities and engaging social events. Transportation support provided either to seniors themselves or through caregivers will be vital linkages for seniors to access all these important services.

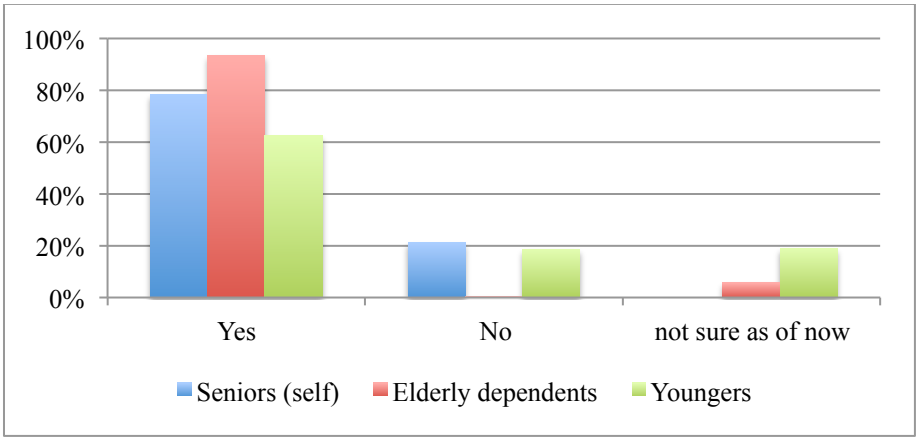


Figure 3.2. Distribution of preferences on aging in place
($n_{Seniors}$=28; $n_{Caregivers\ and\ their\ elderly\ respondents}$=189; $n_{Younger\ people}$=258)

3.4.2. Transportation reality

Travel distance

Figure 3.3 illustrates the distribution of travel distances for daily travels related to shopping, health care, and recreation or social events. Note that, my survey questionnaire does

not gather travel characteristics about commuter trips; instead, I only ask respondents for their daily travel features that are related to shopping, health care, and recreation or social activities. On the one hand, commuter travel features have been discussed and understood well in the literature; on the other hand, along with the aging process, seniors' major travel needs gradually shift from commuting to other daily travels, such as shopping, health care, and recreation or social activities. I find the most common trip distance for daily travels falls into the range between one-half and five miles across all respondent groups and for all types of trip purposes. However, elderly dependents have a higher share of longer travel distance compared with the senior and younger groups, which implies caregivers are facing various challenges in providing transportation support for this group of seniors. Additionally, healthcare related trips have a higher share of longer travel distance compared with shopping, recreation, or social trips. As discussed in earlier essays, health care trips are crucial for many aging Americans to maintain the independence of their daily life. This longer travel distance in health care trips is likely to pose significant challenges to seniors (and their caregivers).

Figure 3.3 also compares the travel distance distribution observed in my MTurk data with that in the 2017 National Household Travel Survey (NHTS) (n= 373,175). It appears my MTurk Survey results are consistent with the 2017 NHTS. For more details on the MTurk data quality, please refer to Essay two.

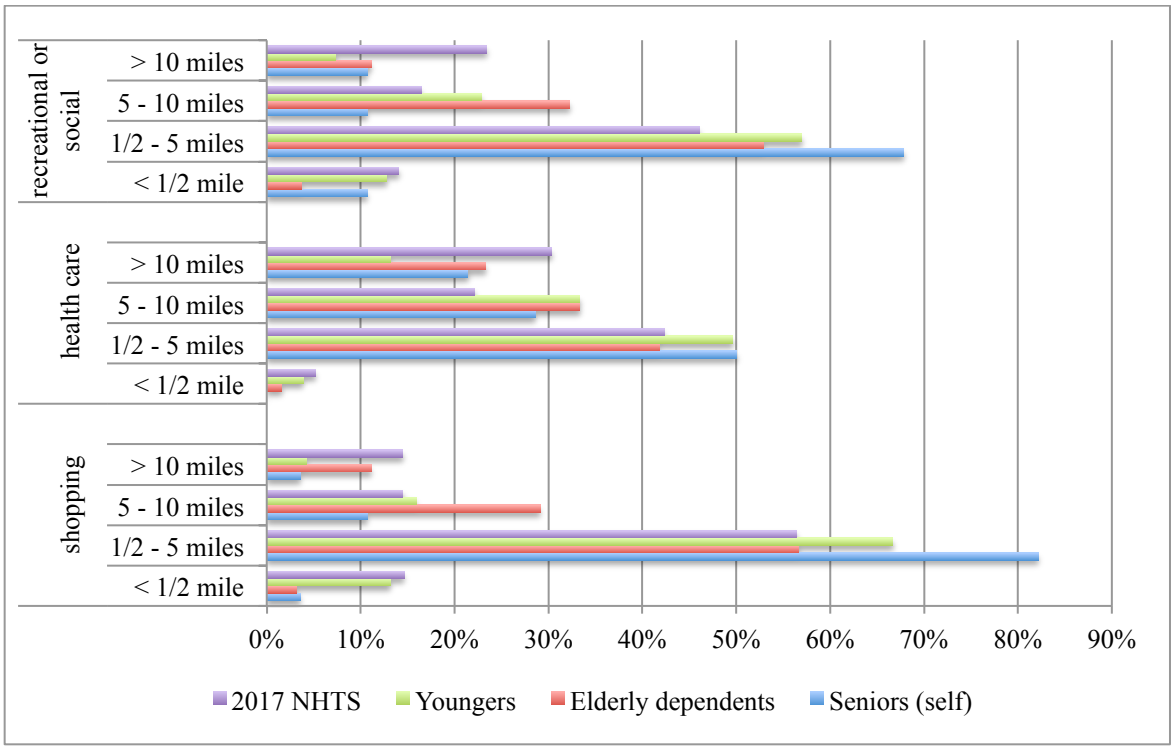


Figure 3.3. Distribution of travel distances for different trip purposes
($n_{Seniors}$=28; $n_{Caregivers\ and\ their\ elderly\ respondents}$=189; $n_{Younger\ people}$=258; $n_{2017\ NHTS}$ = 373,175)

Travel frequency and travel time

Amazon MTurk survey respondents from different categories have different travel frequencies and travel times for daily travels related to dining, shopping, health care, recreation, or social events. As shown in Figure 3.4, a majority of seniors (54%) go out at least three to five times every week; about the same percentage of younger people (56%) go out at least three to five times every week; however, many elderly dependents (59%) only go out less than twice every week. This difference is likely because elderly dependents often have to rely on transportation support from their caregivers or other sources, which, indeed, is verified in the subsequent analysis on the distribution of the most frequently used travel options (shown in Figure 3.6).

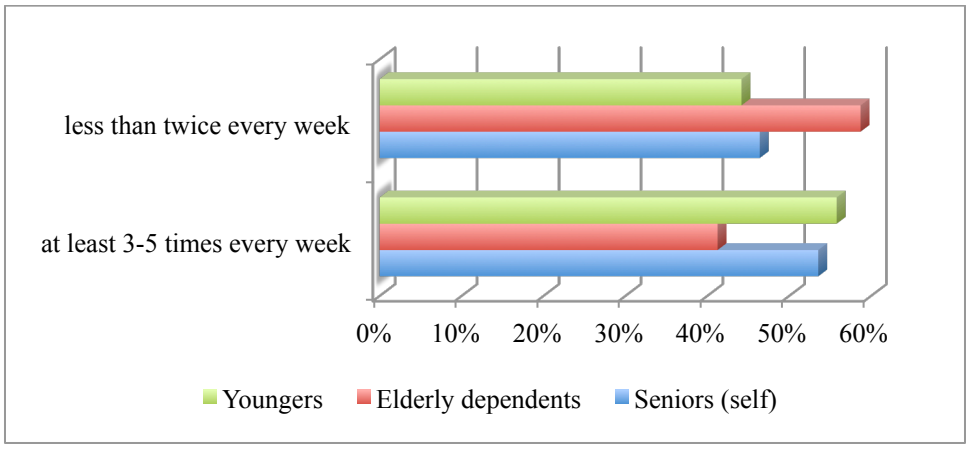


Figure 3.4. Travel frequency for daily travels
($n_{Seniors}$=28; $n_{Caregivers\ and\ their\ elderly\ respondents}$=189; $n_{Younger\ people}$=258)

There exist slightly different distributions in travel time duration among MTurk respondents from different categories (shown in Figure 3.5). The most common travel time duration for daily travels related to dining, shopping, health care, recreation, or social events is between ten and thirty minutes. Nonetheless, elderly dependents have a higher share of travel time that is longer than thirty minutes (21%), compared with senior group and younger group (7%, and 10% respectively). This implies elderly dependents may face more challenges than others on their daily travels.

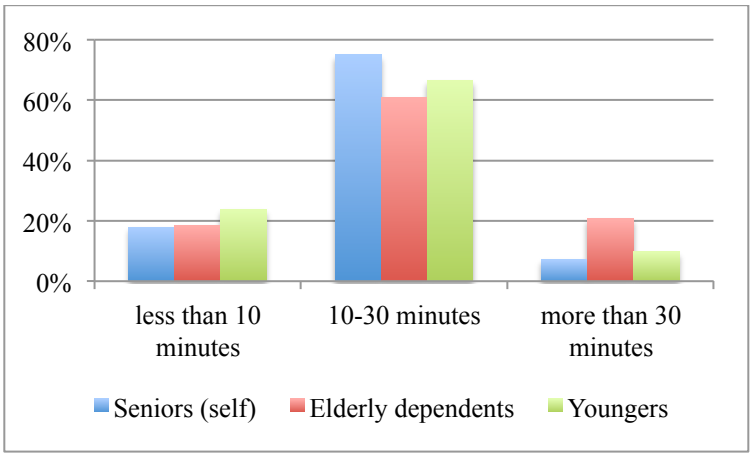


Figure 3.5. Travel time for daily travels
($n_{Seniors}$=28; $n_{Caregivers\ and\ their\ elderly\ respondents}$=189; $n_{Younger\ people}$=258)

3.4.3. Most frequently used travel option

According to MTurk respondents from different categories, there exist significant disparities in the most frequently used travel options (shown in Figure 3.6). Not surprisingly, a majority of senior respondents (64%) usually drive their private vehicles for dining, shopping, health care, recreation, or social events; 29% of seniors often travel by private vehicles as a passenger; and only a small proportion of seniors (7%) frequently walk in their daily travels.

Younger respondents report similar choices in travel options as seniors do. They have a higher share of driving private vehicles (75%); some of them also take private vehicles as a passenger (12%) or walk (7%) for their daily travels; a small portion of them often bike, take trains, or take buses for their daily travels (1%, 1%, and 3%, respectively). My survey questionnaire also asks younger respondents about their tendency of continuing the most frequently used travel modes in the future when they become old. The average Likert score of the tendency statement is 5.9, which is statistically greater than the neutral point 4.0. This indicates younger people not only prefer to age in place but also to continue to rely on their current most frequently used travel modes as long as they can.

However, elderly dependents have a distinct distribution of the most frequently used travel options. First, a majority of elderly dependents (69%) are transported by private vehicles as a passenger for their daily travels. Second, a relatively small portion of elderly dependents (15%) drive themselves, as expected. Third, few elderly dependents walk, bike, take trains, or take buses for their daily travels (2%, 1%, 1%, and 2% respectively). Most interestingly, some elderly dependents have been using options such as paratransit, traditional taxi services, and new "taxi" services (e.g., Uber, Lyft, Sidecar) as their most frequently used travel options (3%, 4%, and 3% respectively). These findings have important implications that show when planning and

operating senior transportation options, one should not only target seniors themselves but also consider caregivers who often play an essential role in planning and facilitating seniors' travel in their daily life.

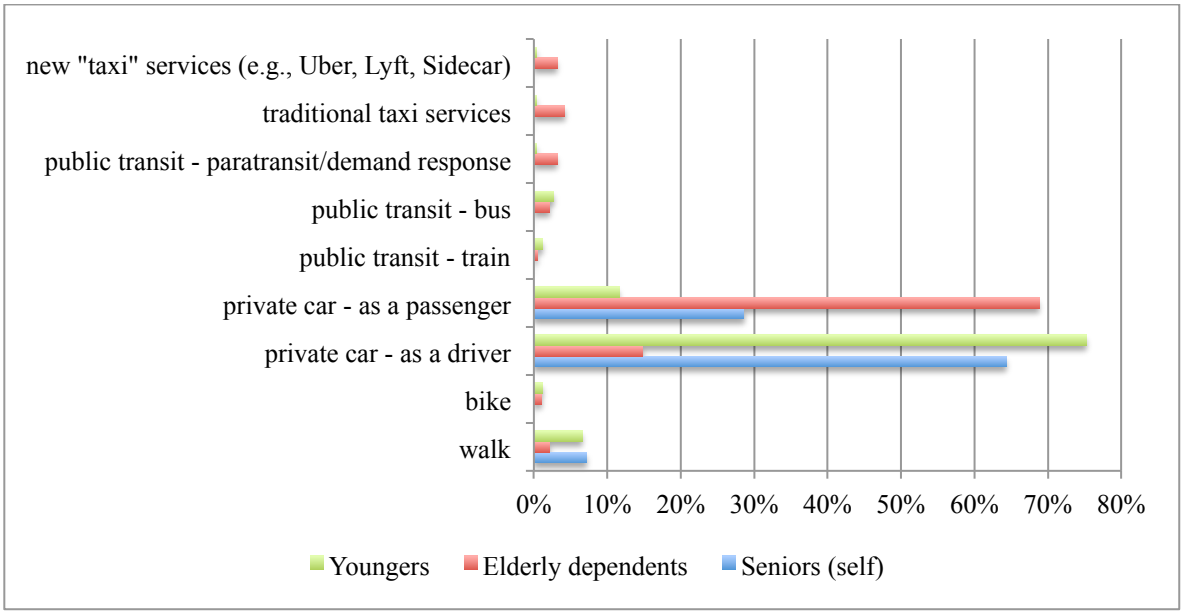


Figure 3.6. Disparities in the most frequently used travel options
($n_{Seniors}$=28; $n_{Caregivers\ and\ their\ elderly\ respondents}$=189; $n_{Younger\ people}$=258)

3.4.4. Behavioral factors affecting travel mode choice

This section investigates behavioral factors related to the most used travel mode for three types of survey respondents (i.e., seniors, elderly dependents, and younger people). These factors include convenience, preference, independence, norm, feasibility, and cost. As discussed earlier, they respectively represent three drivers for one's behavioral change in the TPB: "attitudes," "social norm," and "perceived control."[38] The average behavioral factor scores for all three groups are summarized in Table 3.2. The table also presents the t-test results for mean

[38] "Attitude towards the behavior (Act) is an expression of one's positive or negative evaluation of performing a given behavior. The perceived subjective social norm (SN) reflects personal perception of the social expectations to adopt a given behavior. Perceived behavioral control (PBC) reflects personal beliefs as to how easy or difficult performing the behavior is likely to be. It is assumed to reflect external factors (e.g., availability of time or money, social support) as well as internal factors (e.g., ability, skill, information)" *(Godin and Kok 1996, page 88)*.

comparison with the neutral point (score 4.0 on a 1–7 scale). If the average behavioral score of a factor is statistically greater than the neutral point, that factor is considered as an important factor perceived by the survey respondents.

Perceived importance

The results show younger respondents consider all behavioral factors (i.e., convenience, preference, independence, norm, feasibility, and cost) important in their travel mode choice decisions; however, elderly dependents do not view social norm as an important determining factor to affect their travel mode choices. Furthermore, seniors only value attitude factors (i.e., convenience, preference, and independence) as important elements when they make travel mode choices. To be more specific, seniors think they pick their favorable travel mode not because it is less expensive, not because it is the only feasible transportation options they have, and nor because their friends and neighbors use the same travel option. Instead, seniors value more on travel convenience, their own travel preference (probably formed since the age of sixteen), and their independence of life. These results indicate that the idea of designing and providing low cost and variety types of senior transportation options may not be effective; it is essential to ensure senior transportation options are centered by end-user experiences and consider behavioral factors such as seniors' travel convenience and travel preference, as well as helping seniors to maintain independence.

Table 3.2. Differences in the importance of behavioral factors among different groups

	Seniors	Elderly dependents	Younger people
Convenience	5.93***	5.44***	5.93***
Preference	5.68***	5.41***	5.57***
Independence	5.71***	4.79***	5.48***
Norm	3.86	3.96	4.29***
Feasibility	4.36	5.06***	4.41***
Cost	4.43	4.71***	4.46***

Note: *** $p \leq 0.01$; ** $p \leq 0.05$; * $p \leq 0.1$; $n_{Seniors} = 28$; $n_{Caregivers\ and\ their\ elderly\ respondents} = 189$; $n_{Younger\ people} = 258$

Perceived importance ranking

Further pairwise comparisons of behavioral factor scores using repeated measures ANOVA analysis discover more interesting disparities in the importance ranking of each factor among different respondent groups. As shown in Figure 3.7[39], seniors value factors such as convenience, independence, and preference more important than factors such as cost, feasibility, and norm, when they make their travel mode choices. Through the lens of the TPB, attitude factors are more important driving factors than social norm and perceived control factors perceived by seniors when they make travel mode choice decisions.

[39] Different behavioral factors on the x-axis are ordered from left to right based on the highest mean score to the lowest mean score.

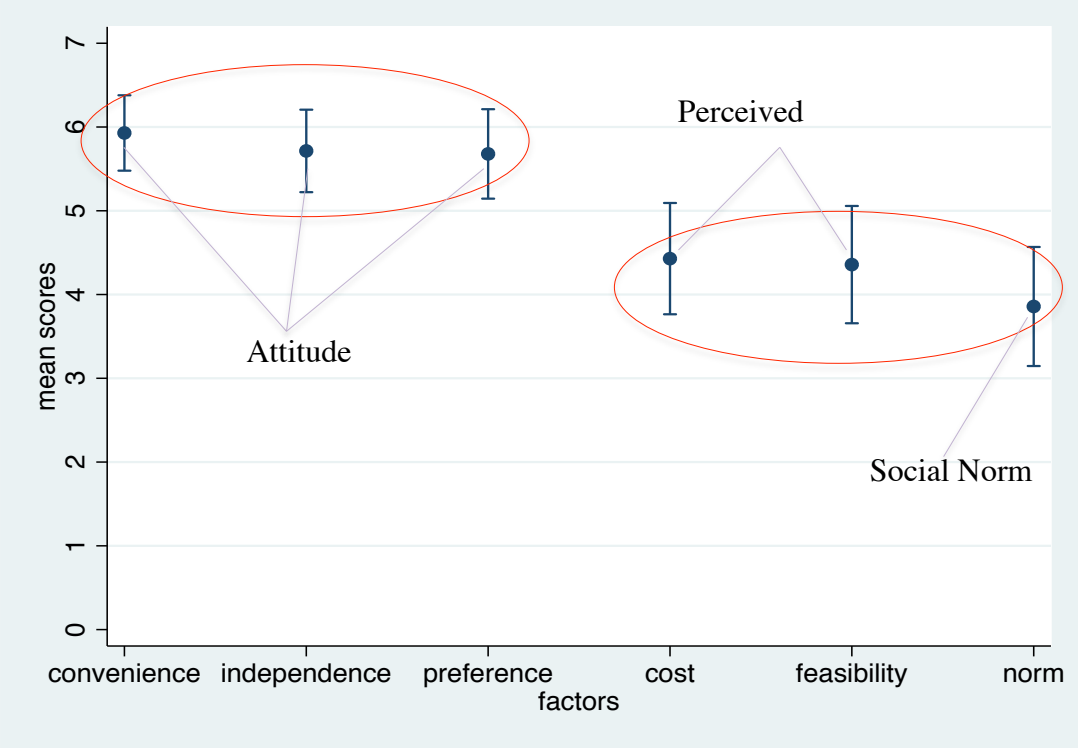


Figure 3.7. Comparisons of average behavioral factor scores for seniors
($n_{Seniors}$=28)

Figure 3.8[40] shows the importance ranking of behavioral factor scores for elderly dependents. Similar to seniors, this group ranks convenience and preferences as the most important factors when making travel mode choices. Moreover, they value feasibility, independence, and cost as the next important factors, while the norm is the least important factor. The factor of independence is not among the most important factors in this case; it may be because elderly dependents have to give it up involuntarily, and they depend on their caregivers or other sources for their travel needs. Nonetheless, these results indicate the attitude factors in the TPB again are perceived as the most influential factors in elderly dependents' travel mode choices.

[40] Different behavioral factors on the x-axis are ordered from left to right based on the highest mean score to the lowest mean score.

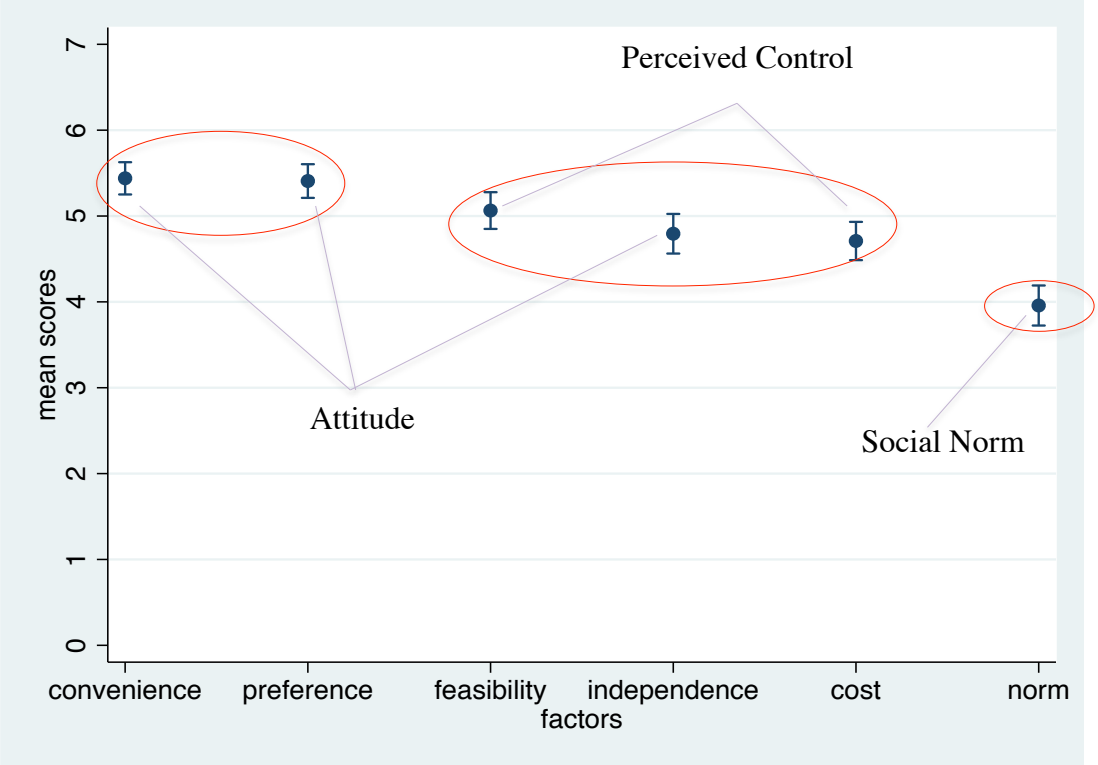


Figure 3.8. Comparisons of average behavioral factor scores for elderly dependents
($n_{\text{Caregivers and their elderly respondents}}$ =189)

Younger respondents report a similar importance ranking as seniors and elderly dependents (shown in Figure 3.9).[41] The most important factor in travel mode choice for younger people is convenience, followed by factors such as preference and independence. Younger people view the factors such as cost, feasibility, and norm as the least important factors when they make travel mode choice decisions. Consistently, attitude factors in the TPB are viewed as more important drivers for younger travelers' mode choices than other factors.

[41] Different behavioral factors on the x-axis are ordered from left to right based on the highest mean score to the lowest mean score.

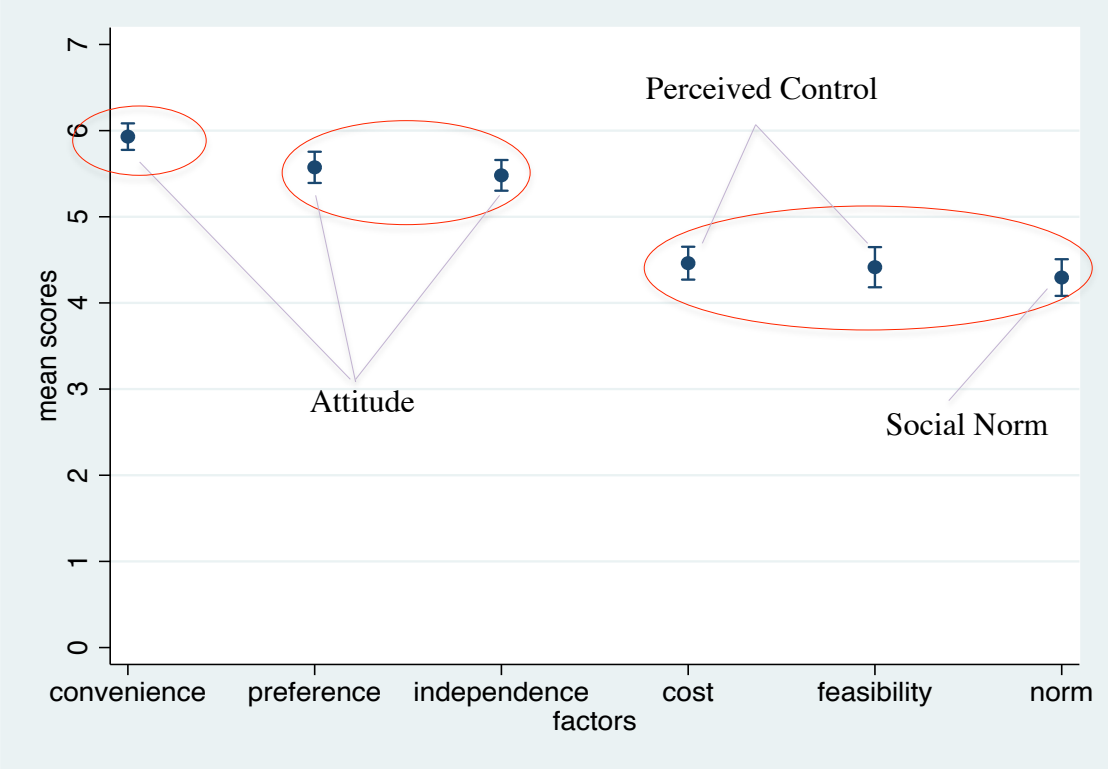


Figure 3.9. Comparisons of average behavioral factor scores for younger people
($n_{\text{Younger people}}$=258)

Overall, it is interesting to find respondents from different groups all rank convenience as the most important factor while ranking social norm as the least important factor when they make travel mode choices. These findings are consistent with some other behavioral researches on the senior population. For instance, usability[42] (equivalent to the convenience factor in my research) was found as one of the most important factors in the research of older adults' technology adoption and use, while independence[43] and social support[44] (equivalent to the social norm factor in my research) were rated as the least important factors *(C. Lee 2014)*. However, the affordability[45] (equivalent to the cost factor in my research) was one of the top-rated factors

[42] How important is it for you to think about if a technology is easy for you to use?
[43] How important is it for you to think about the how you would look to others?
[44] How important is it for you to think about the things that others say about a technology?
[45] How important is it for you to think about the costs associated with getting a technology?

in senior's technology adoption and use, especially during the purchase stage *(C. Lee 2014)*. This ranking difference of cost factor between seniors' technology adoption and use and seniors' mode choices might be because travel demand is relatively inelastic to many factors including cost. In other words, while controlling for other factors, seniors may reject to adopt or use new technology if the cost associated is high; however, seniors may still need to choose a certain type of travel mode in order to make a trip regardless of its cost.

Attitude factors vs. perceived control and social norm factors

As discussed before, since seniors often value travel as a symbol of independence, behavioral factors (derived from TPB) may better explain seniors' mode choices than the traditional mode choice models, which tend to focus more on "utilities" such as travel time/distance and travel cost. In fact, TPB provides a more comprehensive perspective to explain travel behavior—the "perceived behavioral control" aspect can be viewed to contain external factors such as travel time/distance and travel cost that are common predictors in the traditional utility-maximizing theory. In my survey questionnaire, I include two such perceived control factors, feasibility, and cost, which are two external factors that can also be used as predictors in the traditional mode choice models.

To assess which TPB aspect (i.e., attitude, social norm, and perceived behavioral control) alone can explain the most variation in all 475 survey respondents' mode choices, I compare the following three multinomial logit regression models. For all three models, the dependent variable is the most frequently used travel mode. As shown in Figure 3.6, a majority of survey respondents either drive a private car (64% for seniors and 75% for younger people) or take a private car as a passenger (69% for elderly dependents). To facilitate the analysis, the initial ten

types of travel modes are re-categorized into three types of travel modes: private car as a driver (i.e., category 1), private car as a passenger (i.e., category 2), and others (i.e., category 3). Behavioral factors under each TPB aspect, i.e., attitude, norm, and perceived behavioral control, are selected as independent variables for each of the three multinomial logit models, respectively (shown in Equation 3.1, 3.2, and 3.3). Using category 1 as the reference, then for category m = 2, 3, we have the following model specifications.

$$\ln\left[\frac{p(Y=m)}{p(Y=1)}\right] = \beta_0 + \beta_1 X_{Convenience} + \beta_2 X_{Preference} + \beta_3 X_{Independence} \ldots \text{ Equation 3.1}$$

$$\ln\left[\frac{p(Y=m)}{p(Y=1)}\right] = \beta_0 + \beta_1 X_{Social\ norm} \ldots \text{ Equation 3.2}$$

$$\ln\left[\frac{p(Y=m)}{p(Y=1)}\right] = \beta_0 + \beta_1 X_{Feasibility} + \beta_2 X_{cost} \ldots \text{ Equation 3.3}$$

Note that, Equation 3.1 only accounts for factors in the attitude aspect of TPB; Equation 3.2 only accounts for the norm aspect of TPB; Equation 3.3 only accounts for perceived behavioral control aspect of TPB and can be viewed as a traditional model that focuses only on "utilities," i.e., feasibility and cost.

To compare these three models, I calculate the Bayesian information criterion (BIC) values of each model. BIC is a commonly used penalized-likelihood criterion for choosing the best fit model in regression *(Raftery 1995)*. In general, a model with the lowest BIC is preferred, indicating the model provides the best fit of the data than other models, adjusting for the number of independent variables included in the model. In other words, a model with more independent variables may not have a lower BIC (i.e., provide a better fit of the data) than other models, unless the included independent variables can significantly better explain the variation in the outcome variable. Table 3.3 shows the BIC values for each of the three multinomial logit models. The model using attitude factors alone (e.g., convenience, preference, independence)

returns the lowest BIC value, confirming these behavioral factors collectively provide the best fit for the data. In contrast, the model containing only perceived control factors (e.g., feasibility and cost) returns the highest BIC value, indicating this TPB aspect has the worst fit for survey respondents' travel mode choices among all TPB aspects.

Table 3.3. Comparison of predictors using BIC values

TPB Aspect	Behavioral Factors	BIC
Attitude	Convenience Preference Independence	860.05
Social norm	Social norm	934.84
Perceived behavioral control	Feasibility Cost	952.19

Note: n = 475

In summary, the Theory of Planned Behavior provides a more comprehensive framework to explain travelers' travel mode choices. Factors related to perceived control and social norm (e.g., cost, feasibility, and norm) may not explain my MTurk survey respondents' travel mode choices well. In contrast, attitude factors (e.g., convenience, independence, and preference) are probably the most important driving elements when (senior) people make travel mode choice decisions, which, however, are often overlooked during the (senior) transportation planning and operation process.

3.4.5. Preferences on the sources of senior transportation support

This section investigates respondents' preferences on the sources of senior transportation support, including support from neighbors, community centers, public agencies, private services, or family members and friends. Again, a seven-point disagree-agree Likert scale[46] is used for

[46] 1: strongly disagree, 2: disagree, 3: somewhat disagree, 4: neither disagree nor agree, 5: somewhat agree, 6: agree, and 7: strongly agree

statements representing different sources of senior transportation support. For each source of senior transportation support, the survey asks to what extent (score 1–7) each respondent prefers this source of support. Table 3.4 shows the average preference scores for each source, as well as the t-test results for mean comparison with the neutral point.[47] Note that a source with its average preference score statistically greater than the neutral point is considered as an important one perceived by the survey respondents. Younger respondents value a variety of senior transportation support sources as important ones, including support from family members and friends, private services, and public agencies. Seniors consider support from both family members and friends and private services as important sources of senior transportation options, while elderly dependents only view transportation support from family members and friends as an important source. Figure 3.10[48] shows the results of the AVOVA pairwise comparisons of average support preference scores for different respondent groups. The importance rankings are slightly different for each group. However, support from family members and friends is always perceived as the most important source.

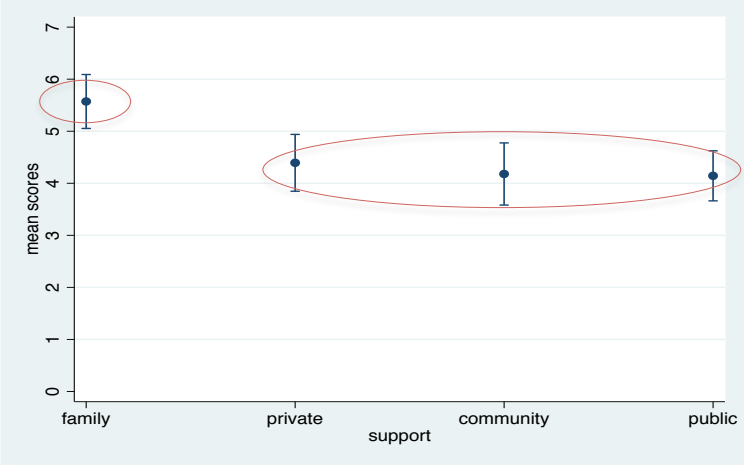
Table 3.4. Different preferences of transportation support among different groups

Support from	Seniors (self)	Elderly dependents	Younger people
Community	4.18	3.52	4.04
Public	4.14	3.15	4.18**
Private	4.39*	3.42	4.37***
Family	5.57***	6.11***	5.54***

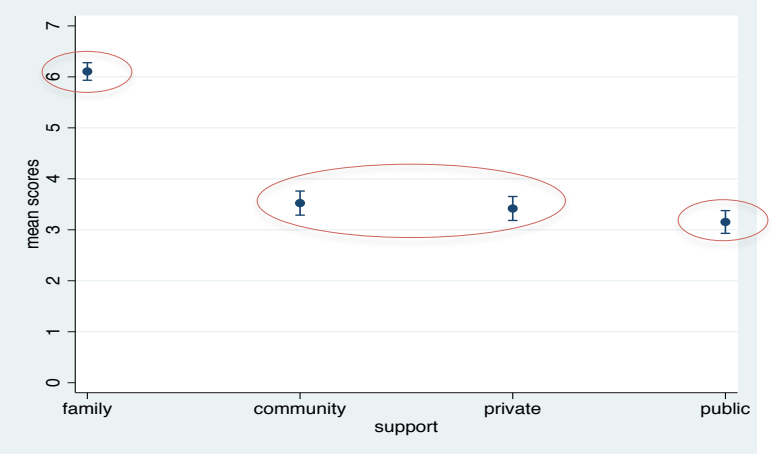
Note: *** p≤ 0.01; ** p≤ 0.05; * p≤ 0.1; $n_{Seniors}$ =28; $n_{Caregivers\ and\ their\ elderly\ respondents}$ =189; $n_{Younger\ people}$ =258

[47] score 4 on a 1-to-7 scale

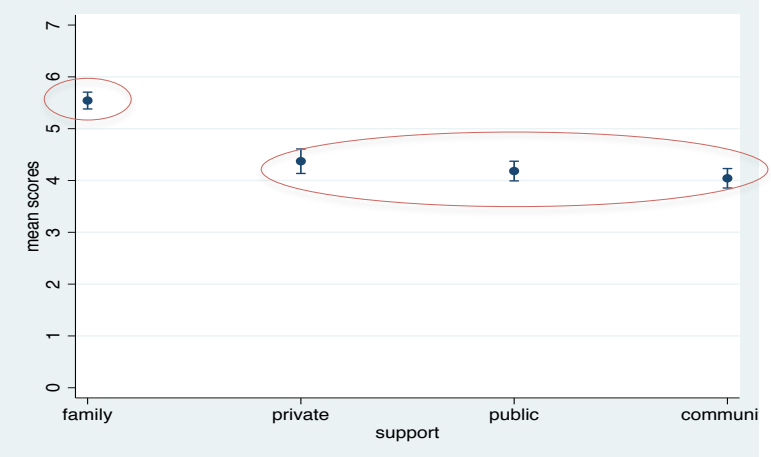
[48] Different sources of senior transportation support on the x-axis are ordered from left to right based on the highest mean score to the lowest mean score.



Seniors



Elderly dependents



Younger people

Figure 3.10. Comparisons of average support preference scores

($n_{Seniors}$=28; $n_{Caregivers\ and\ their\ elderly\ respondents}$=189; $n_{Younger\ people}$=258)

These results have important policy implications. First, younger respondents state they are open to more types of support of senior transportation options, which hopefully will lead to a higher level of acceptance of various senior transportation options in the future when they age. Second, respondents from all different groups value transportation support provided by family members and friends the most. It suggests promoting family- and friend-like senior transportation support could attract more users. The operating mode of ITNAmerica (as discussed in the literature review section) actually is an example of this concept.

For elderly dependents, the only source viewed as important is the support from family members and friends. At the same time, more than 90 percent of the caregiver respondents have provided help to their elderly dependents in meeting their transportation needs (see Table 3.5). Among caregivers, about half of them have arranged transportation services for their elderly dependent. The most frequently used senior transportation services by caregivers include help from relatives and friends (25%), community-based services (21%), services from public agencies (17%), and services from private companies (14%) (see Table 3.5). However, more significantly, about three-quarters of caregivers have to assist their elderly dependents when traveling. Over 80 percent of caregivers need to help their elderly dependent on transportation access very often or sometimes (see Table 3.5). When asking about the convenience of providing elderly dependent transportation support, the average Likert score is 3.84, which is statistically lower than the neutral point 4.0. These results indicate it is not convenient for caregivers to arrange transportation access for their elderly dependents, and transportation needs from elderly dependents bring significant burdens to their caregivers who may already have a busy daily schedule.

Table 3.5. Caregiver helps on elderly dependent's transportation needs

	Percentage
Types of caregiver help for elderly dependents' transportation needs	
Arrange a transportation service	44%
Assist transportation needs themselves	70%
No	7%
Most frequently used senior transportation services by caregivers	
Community-based services	21%
Services from public agencies	17%
Services from private companies	14%
Help from relatives/friends	25%
Frequency of providing elderly dependent's transportation support	
Very often or sometimes	83%
Occasionally	17%

Note: $n_{\text{Caregivers and their elderly respondents}} = 189$

3.4.6. Attitudes towards information channels of senior transportation options

This section analyzes respondents' preferable channels from which they want to receive information about (new) senior transportation options. Table 3.6 shows the average preference scores for each channel, along with the t-test results for mean comparison with the neutral point.[49] Similar to the previous analyses, a channel with its average preference score statistically greater than the neutral point is considered as an important one perceived by the survey respondents. It is encouraging to find out that respondents across all three groups value all types of information channels of senior transportation options, including neighbors, community centers, public agencies, private agencies, and family members and friends, as important ones. Moreover, they state they would like to use the options promoted via any of these information channels.

[49] score 4 on the 1–7 scale

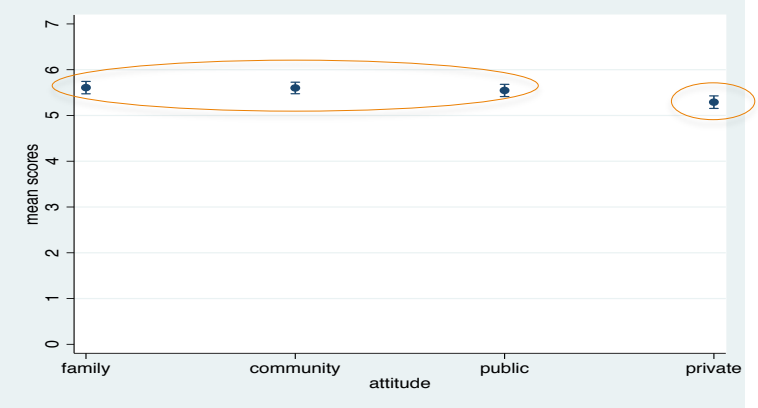
Table 3.6. Attitudes towards information channels of senior transportation options

Channels	Seniors (self)	Elderly dependents	Younger people
Community	5.11***	4.57***	5.60***
Public	5.18***	4.48***	5.55***
Private	5.18***	4.48***	5.29***
Family	5.43***	4.83***	5.61***

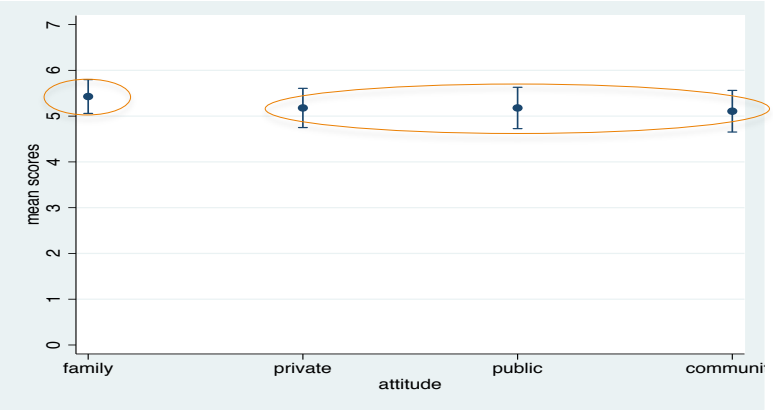
Note: *** $p \leq 0.01$; ** $p \leq 0.05$; * $p \leq 0.1$; $n_{Seniors} = 28$; $n_{Caregivers\ and\ their\ elderly\ respondents} = 189$; $n_{Younger\ people} = 258$

However, respondents from different groups rank their preferences among these information channels in a slightly different way, which is evaluated by the pairwise comparisons of Likert scores using repeated measures ANOVA analysis (see Figure 3.11).[50] Younger respondents value information channels such as family members, public agencies, and community organizations more important than private channels. Seniors and elderly dependents share similar rankings of different information channels, where they value information received from family members more important than that received from other sources (e.g., public agencies, private companies, and community organizations). However, senior respondents report a higher magnitude of importance levels than elderly dependents. The possible reason behind this difference is seniors may rely more on these information channels of senior transportation options than elderly dependents who typically have their caregivers arrange their travels.

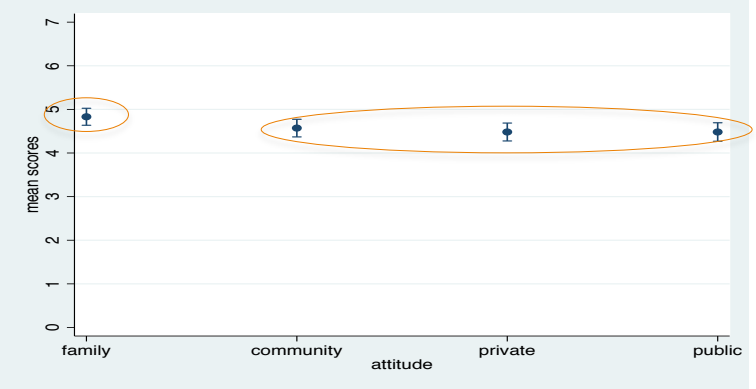
[50] Different information channels of senior transportation options on the x-axis are ordered from left to right based on the highest mean score to the lowest mean score.



a. Younger people



b. Seniors



c. Elderly dependents

Figure 3.11. Comparisons of average information channel attitude scores
($n_{Seniors}$=28; $n_{Caregivers\ and\ their\ elderly\ respondents}$=189; $n_{Younger\ people}$=258)

3.5. Summary and Future Work

As more and more aging Americans turn sixty-five, planning effective senior transportation options and providing effective senior transportation services has become

increasingly challenging to many stakeholders, including public agencies, community organizations, and private companies. However, we have relatively limited knowledge about behavioral factors that affect seniors' mode choices, from whom seniors or their caregivers would like to get transportation services or their attitudes towards information channels that publicize senior transportation options. My behavioral survey study of senior transportation options attempts to fill in these important knowledge gaps, and the survey is implemented via the innovative Amazon Mechanical Turk (MTurk) crowdsourcing platform.

My MTurk survey first explores different types of respondents' living environment and transportation reality. Results reveal most seniors, including elderly dependents, live in their own housing properties in low-density areas with limited existing public or private transportation options. Nonetheless, about 80 percent of seniors and 94 percent of elderly dependents plan to age in place for as long as they can. It is also found most trips seniors and elderly dependents made for their daily needs are beyond the comfortable walking distance; health care trips tend to be longer than other types of trips; elderly dependents have a higher share of longer travel time. These findings affirm that addressing seniors' transportation needs is crucial and at the same time challenging.

A majority of the respondents use private vehicles as their most frequently used mode choices for their daily travels; however, the shares of being a driver or being a passenger are quite different among different groups. For instance, 64% of seniors are often driving, and 29% of them are often transported by private vehicles as a passenger; 75% of younger people often drive, while 12% of them are often a passenger of a private vehicle. In contrast, 69% of elderly dependents are often a passenger of a private vehicle, and only 15% of them often drive themselves. Such a significant disparity implies not only seniors themselves but also caregivers

should be considered in the planning and operating process of senior transportation options since caregivers often play an essential role in facilitating seniors' travels in their daily life.

The analyses of behavioral factors that are based on different aspects of the Theory of Planned Behavior show interesting results as well. First, respondents from different groups value behavioral factors quite differently. For instance, younger people and elderly dependents value most of the behavioral factors as important ones when they make travel mode choices for their daily travel, but seniors do not care about travel cost, travel feasibility, or social norm attached to a certain travel mode. Second, different user groups perceive different importance rankings for TPB factors when they make their travel mode choice decisions. Nonetheless, for seniors and elderly dependents, attitude factors (e.g., convenience, preference, and independence) are generally perceived as more important drivers for their mode choices than other aspects (e.g., social norm, feasibility, and cost).

The investigation of preferences on sources of senior transportation support shows respondents from all different groups value transportation support provided by family members and friends the most, suggesting that promoting family- and friend-like senior transportation support could gain more trust and attract more users. Such findings, together with the analyses of caregivers' travel features, further affirm caregivers face various challenges when supporting their elderly dependents' travel needs. The encouraging news, however, is respondents across all three groups view all types of information channels that publicize senior transportation options as important ones, where information received from family members and friends is ranked the most important one for all survey respondents. More importantly, respondents of all different groups state they are willing to use the options promoted via these information channels.

One limitation of my survey study is that instead of directly asking elderly dependents' own opinions about senior transportation options, I surveyed caregivers and asked caregivers, based on their observation and in their opinion, their elderly dependents' living environment, transportation reality, preferences on transportation options, and attitudes towards new transportation options. Caregivers can be viewed as an important end-user group who chooses and arranges senior transportation services for their elderly dependents; so, it is critical to understand caregivers' observations and perceptions on their elderly dependents' transportation options. It would be helpful to recruit both caregivers and their elderly dependents in future survey studies. This way, more comprehensive information about senior transportation options can be collected and analyzed.

In addition, my research findings suggest several other directions for future studies. First, my study finds that for seniors and elderly dependents behavioral factors such as convenience, preference, and independence (i.e., attitude aspects in the TPB) are perceived as more important drivers for their mode choice than other factors such as social norm, feasibility, and cost. Future research could attempt to include these behavioral factors and collect data to *predict* seniors travel mode choices. Such a prediction model will be useful for transportation policy makers and service providers. Second, my study uses TPB to guide the research design and data analysis; it would be of interest to use other behavioral theories to study seniors' transportation preferences. Third, from a practical point of view, it is important to develop interventions that can be used to educate seniors with existing and new transportation options and to encourage seniors to select more suitable options to meet their individual needs.

For planners and decision makers, my study establishes empirical evidence that users of senior transportation services do not limit to seniors themselves. Therefore, needs from different

types of user groups should all be carefully assessed and considered in the planning and implementation process of senior transportation solutions. My study also suggests that instead of the traditional travel mode choice model which emphasizes "utilities" such as travel time/distance and travel cost, planners and service providers need to pay more attention to behavioral factors (such as convenience, preference, and independence), when developing and operating senior transportation options. Last but not least, my study advocates that planning agencies and service providers should market their services through different communications channels in order to promote the usage of existing and new senior transportation options.

Summary of Three Dissertation Essays

The baby boomer generation has been entering their age of sixty-five since 2011. Twenty percent of the U.S. population will be over age sixty-five by 2030. Such a rapidly aging population has posed great challenges to transportation planning and operating agencies since this large number of aging boomers demand dependable transportation access so they can remain independent and age in place. It is crucial, in a timely manner, to understand aging Americans' travel mode choices, their preferences and perspectives on transportation support, and communication channels that they prefer to receive information on transportation options. My dissertation presents three essays to explore these important and urgent issues.

Essay One uses the 2009 National Household Travel Survey (NHTS) data to investigate whether the predominant travel preference—favoring private automobiles—holds for different groups of aging Americans. The analyses not only include the commonly used travel mode choice factors, such as socio-demographics, built environment, and transportation attributes; but also include behavioral aspects such as attitudes towards safety, congestion, public transit, and walking environment.

Essay Two demonstrates my own survey on senior transportation options. A comprehensive survey questionnaire is constructed for various user groups of senior transportation services, including seniors, caregivers and elderly dependents, and younger people. The survey is then successfully implemented on the Amazon Mechanical Turk (MTurk) crowdsourcing platform.

Essay Three analyzes my MTurk survey data and investigates the impact of behavioral factors derived from the Theory of Planned Behavior (TPB) on travel mode choices among

different user groups of senior transportation services. I also investigate survey respondents' preferences on types of senior transportation support, as well as respondents' preferable channels from which they want to receive information about senior transportation options.

Throughout my three dissertation essays, I have highlighted a few important policy implications and recommendations. First, users of senior transportation services do not limit to seniors themselves. They can come from a much wider population, such as caregivers who often need to arrange transportation services for their elderly dependents and younger people who will be future customers of senior transportation services. Indeed, results in Essay Three find similarities as well as disparities in transportation features, preferences, and attitudes among different respondent groups. These findings imply that when planning and operating senior transportation services, needs from different types of user groups should be addressed; and different intervention strategies may be used towards different user groups to achieve a better outcome. In fact, results in Essay One show although it may not be effective for existing seniors, promoting positive attitudes on certain travel options that were otherwise not preferred by middle-aged boomers (e.g., public transit) could be a way to encourage this group of boomers to change their future travel mode preferences and choices.

Second, planning researchers, practitioners, and service providers may utilize innovative online tools or crowdsourcing platforms, such as Amazon MTurk, to tackle planning related issues, especially those that need timely resolutions. In particular, these resources can often be effective, efficient, and inexpensive to collect data, to implement the survey, and to conduct experiments. As demonstrated in Essay Two, I am able to successfully implement my survey on senior transportation options via MTurk. Results show my survey gathers meaningful insights of senior transportation options from different respondent groups, including seniors, caregivers and

elderly dependents, and younger people. Survey data collected from MTurk represents a fairly diversified population with different socio-demographic features; and it shares a similar distribution pattern as those observed in the general population data (e.g., Census) and the large-scale nationwide transportation survey using random sampling method (e.g., NHTS). These results indicate Amazon MTurk can be a valuable crowdsourcing platform for planning related surveys, experiments, and data collections, especially when addressing timely issues such as aging Americans' travel needs.

Third, behavioral factors are important drivers in seniors' travel mode choices. For seniors, travel is often beyond the simple description of origins and destinations; it is a symbol of independence, and it is a critical factor for quality of life. Instead of the traditional travel mode choice model, which focuses more on "utilities" such as travel time/distance and travel cost, I introduce behavioral factors derived from TPB as potentially more important factors. In fact, TPB is a more comprehensive concept, in which "perceived behavioral control" aspect can actually contain external factors such as travel time/distance and travel cost that are common predictors in the traditional utility-maximizing theory. As shown in Essay Three, attitude factors in TPB (i.e., convenience, preference, and independence) are perceived as more important drivers for seniors' mode choices than other aspects (i.e., social norm, feasibility, and cost), suggesting more attention should be drawn to attitude factors, rather than focusing on traditional concerns such as feasibility and cost, during the senior transportation planning and operation process.

Fourth, results in Essay One show no evidence that Americans are giving up driving as they age. Therefore, planning as though current seniors want to give up private auto travel as they age is not likely to be successful. At the same time, results in Essay Three indicate

transportation support from family members and friends are highly valued by seniors, elderly dependents, and even younger people who will be future customers of senior transportation services. Thus, although traditional public transportation services may not fit seniors' preferences, promoting family- and friend-like senior transportation support could instead gain more trust and attract more users. The operating mode of ITNAmerica (as discussed in the Essay Three) is an example of this concept. It is also encouraging to find from Essay Three's analyses that respondents across all three user groups value all the information channels of senior transportation options and that they are willing to use the options promoted via these information channels. These findings indicate when planning agencies design and service providers operate new senior transportation options, they should market new options through multiple communication channels, including community centers, public agencies, private commercials, and seniors' family members, because all these channels are likely to reach potential users.

References

Allström, Andreas, Ida Kristoffersson, and Yusak Susilo. 2017. "Smartphone Based Travel Diary Collection: Experiences from a Field Trial in Stockholm." *Transportation Research Procedia* 26: 32–38.

Alsnih, Rahaf, and David A. Hensher. 2003. "The Mobility and Accessibility Expectations of Seniors in an Aging Population." *Transportation Research Part A: Policy and Practice* 37 (10): 903–16.

AoA. 2010. "A Profile of Older Americans: 2010." Administration on Aging (AoA), U.S. Department of Health and Human Services. https://www.acl.gov/sites/default/files/Aging%20and%20Disability%20in%20America/2010profile.pdf.

Bailey, Linda. 2004. "Aging Americans: Stranded without Options." Surface Transportation Policy Project. http://www.ctaa.org/webmodules/webarticles/articlefiles/aging_stranded.pdf.

Bandura, Albert. 1986. *Social Foundations of Thought and Action: A Social Cognitive Theory*. Prentice Hall.

Barrett, Linda. 2014. "Home and Community Preferences of the 45+ Population 2014." AARP. https://www.aarp.org/content/dam/aarp/research/surveys_statistics/il/2015/home-community-preferences.doi.10.26419%252Fres.00105.001.pdf.

Barton, Benjamin K., Susan M. Kologi, and Anne Siron. 2016. "Distracted Pedestrians in Crosswalks: An Application of the Theory of Planned Behavior." *Transportation Research Part F: Traffic Psychology and Behaviour* 37: 129–37.

Bausell, R. Barker, and Yu-Fang Li. 2002. *Power Analysis for Experimental Research: A Practical Guide for the Biological, Medical and Social Sciences*. Cambridge University Press.

Bayart, Caroline, and Patrick Bonnel. 2015. "How to Combine Survey Media (Web, Telephone, Face-to-Face): Lyon and Rhône-Alps Case Study." *Transportation Research Procedia* 11: 118–35.

Belser, Ann. 2014. "More Seniors Staying in the Labor Market, Data Shows - Employers Finding Older Workers Are Reliable Employees." *Pittsburgh Post-Gazette*, May 25, 2014. http://www.post-gazette.com/business/2014/05/25/Labor-market-flooded-by-seniors-data-shows/stories/201405250184.

Berinsky, Adam J., Gregory A. Huber, and Gabriel S. Lenz. 2012. "Evaluating Online Labor Markets for Experimental Research: Amazon. Com's Mechanical Turk." *Political Analysis* 20 (3): 351–68.

Blumenberg, Evelyn, Moira Donahue, Susan L. Handy, Kristin Lovejoy, Caroline J. Rodier, Susan Shaheen, and James Volker. 2007. "Travel of Diverse Populations: Literature Review." California PATH Working Paper UCB-ITS-PWP-2007-5. Institute of Transportation Studies, University of California, Davis.

Broache, Anne. 2012. "Perspectives on Seattle Women's Decisions to Bike for Transportation." University of Washington.

Buhrmester, Michael, Tracy Kwang, and Samuel D. Gosling. 2011. “Amazon’s Mechanical Turk: A New Source of Inexpensive, yet High-Quality, Data?” *Perspectives on Psychological Science* 6 (1): 3–5.
Byrnes, James P., David C. Miller, and William D. Schafer. 1999. “Gender Differences in Risk Taking: A Meta-Analysis.” *Psychological Bulletin* 125 (3): 367.
Cambridge Systematics, Inc. 2007. “PSRC 2006 Household Activity Survey Analysis Report.” PSRC. https://www.psrc.org/sites/default/files/finalreport_2006.pdf.
CDC. 2017. “Healthy Places Terminology.” *Healthy Places Terminology*. Centers for Disease Control and Prevention. https://www.cdc.gov/healthyplaces/terminology.htm.
Census, US Census. 2014. “From Living Arrangements to Labor Force Participation, New Analysis Looks at State of the Nation’s 65-and-Older Population.” The United States Census Bureau. June 30, 2014. https://www.census.gov/newsroom/press-releases/2014/cb14-124.html.
Cohen, Jacob. 1988. *Statistical Power Analysis for the Behavioral Sciences. 2nd*. Hillsdale, NJ: erlbaum.
Colby, Sandra L., and Jennifer M. Ortman. 2014. “The Baby Boom Cohort in the United States: 2012 to 2060.” P25-1141. Current Population Reports. U.S. Census Bureau. https://www.census.gov/prod/2014pubs/p25-1141.pdf.
Collia, Demetra V., Joy Sharp, and Lee Giesbrecht. 2003. “The 2001 National Household Travel Survey: A Look into the Travel Patterns of Older Americans.” *Journal of Safety Research* 34 (4): 461–70.
Comendador, Julio, and M. E. López-Lambas. 2016. “Pain and Joy of a Panel Survey on Transport Studies.” *Transportation Research Procedia* 18: 248–55.
Coughlin, Joseph. 2001. “Transportation and Older Persons: Perceptions and Preferences: A Report on Focus Groups.” AARP, Public Policy Institute Washington, DC.
Cristea, Mioara, and Alexandra Gheorghiu. 2016. “Attitude, Perceived Behavioral Control, and Intention to Adopt Risky Behaviors.” *Transportation Research Part F: Traffic Psychology and Behaviour* 43: 157–65.
Deb, Shuchisnigdha, Lesley Strawderman, Daniel W. Carruth, Janice DuBien, Brian Smith, and Teena M. Garrison. 2017. “Development and Validation of a Questionnaire to Assess Pedestrian Receptivity toward Fully Autonomous Vehicles.” *Transportation Research Part C: Emerging Technologies* 84: 178–95.
Deb, Shuchisnigdha, Lesley Strawderman, Janice DuBien, Brian Smith, Daniel W. Carruth, and Teena M. Garrison. 2017. “Evaluating Pedestrian Behavior at Crosswalks: Validation of a Pedestrian Behavior Questionnaire for the US Population.” *Accident Analysis & Prevention* 106: 191–201.
Dize, Virginia. 2013. *Testimony for the Hearing on “Transportation: A Challenge to Independence for Seniors” before the U.S. Senate Special Committee on Aging*. Washington D.C. https://www.gpo.gov/fdsys/pkg/CHRG-113shrg25451/pdf/CHRG-113shrg25451.pdf.
Dominik, Bieland, Sommer Carsten, and Witte Claudia. 2017. “Uncommon Leisure Traffic–Analyses of Travel Behaviour of Visitors.” *Transportation Research Procedia* 25: 3971–84.
Douissembekov, Evgueni, Catherine Gabaude, Joceline Rogé, Jordan Navarro, and George A. Michael. 2014. “Parking and Manoeuvring among Older Drivers: A

Survey Investigating Special Needs and Difficulties." *Transportation Research Part F: Traffic Psychology and Behaviour* 26: 238–45.
Emond, Catherine R., and Susan L. Handy. 2012. "Factors Associated with Bicycling to High School: Insights from Davis, CA." *Journal of Transport Geography* 20 (1): 71–79.
Emond, Catherine R., Wei Tang, and Susan L. Handy. 2009. "Explaining Gender Difference in Bicycling Behavior." *Transportation Research Record* 2125 (1): 16–25.
Fan, Yingling, Andrew Guthrie, and David Levinson. 2016. "Waiting Time Perceptions at Transit Stops and Stations: Effects of Basic Amenities, Gender, and Security." *Transportation Research Part A: Policy and Practice* 88: 251–64.
Farber, Nicholas, Douglas Shinkle, Jana Lynott, Wendy Fox-Grage, and Rodney Harrell. 2011. "Aging in Place: A State Survey of Livability Policies and Practices." National Conference of State Legislatures, AARP Public Policy Institute. https://assets.aarp.org/rgcenter/ppi/liv-com/aging-in-place-2011-full.pdf.
Fehr & Peers Transportation Consultants. 2017. "2013 - 2017 Travel Decision Survey Data Analysis and Comparison Report." https://www.sfmta.com/sites/default/files/reports/2017/Travel_Decision_Survey_Comparison_Report_2017-Accessible.pdf.
FHWA. 2011. "2009 National Household Travel Survey (NHTS) User's Guide." U.S. Department of Transportation, Federal Highway Administration. http://nhts.ornl.gov/2009/pub/UsersGuideV2.pdf.
———. 2018. "Introduction to the 2009 NHTS." 2018. https://nhts.ornl.gov/introduction.shtml.
Fideler, Elizabeth F. 2014. "Why Seniors Are on the Job and Staying There." National Journal. http://www.nationaljournal.com/next-america/perspectives/why-seniors-are-on-the-job-and-staying-there-20140213.
Frater, Jillian, Roeline Kuijer, and Simon Kingham. 2017. "Why Adolescents Don't Bicycle to School: Does the Prototype/Willingness Model Augment the Theory of Planned Behaviour to Explain Intentions?" *Transportation Research Part F: Traffic Psychology and Behaviour* 46: 250–59.
Frater, Jillian, John Williams, Debbie Hopkins, Charlotte Flaherty, Antoni Moore, Simon Kingham, Roeline Kuijer, and Sandra Mandic. 2017. "A Tale of Two New Zealand Cities: Cycling to School among Adolescents in Christchurch and Dunedin." *Transportation Research Part F: Traffic Psychology and Behaviour* 49: 205–14.
Freund, Katherine. 2013. *Testimony for the Hearing on "Transportation: A Challenge to Independence for Seniors" before the U.S. Senate Special Committee on Aging*. Washington, D.C. https://www.gpo.gov/fdsys/pkg/CHRG-113shrg25451/pdf/CHRG-113shrg25451.pdf.
Frost-Steward, Jill M. 2015. "'It Seems like It Should Be so Simple': The Role of the Family in Elder Driving Retirement." Kansas State University.
Gavrilov, Leonid A., and Patrick Heuveline. 2003. "Aging of Population." *The Encyclopedia of Population* 1: 32–37.

Godin, Gaston, and Gerjo Kok. 1996. “The Theory of Planned Behavior: A Review of Its Applications to Health-Related Behaviors.” *American Journal of Health Promotion* 11 (2): 87–98.
Goldwyn, Eric L. 2017. *An Informal Transit System Hiding in Plain Sight: Brooklyn’s Dollar Vans and Transportation Planning and Policy in New York City*. Columbia University.
Guo, Zhan, Jinhua Zhao, Chris Whong, Prachee Mishra, and Lance Wyman. 2017. “Redesigning Subway Map to Mitigate Bottleneck Congestion: An Experiment in Washington DC Using Mechanical Turk.” *Transportation Research Part A: Policy and Practice* 106: 158–69.
Haboucha, Chana J., Robert Ishaq, and Yoram Shiftan. 2017. “User Preferences Regarding Autonomous Vehicles.” *Transportation Research Part C: Emerging Technologies* 78: 37–49.
Hall, Peter. 2014. *Cities of Tomorrow: An Intellectual History of Urban Planning and Design since 1880*. John Wiley & Sons.
Handy, Susan. 2005. “Critical Assessment of the Literature on the Relationships among Transportation, Land Use, and Physical Activity.” Resource paper for TRB Special Report 282. Transportation Research Board and the Institute of Medicine Committee on Physical Activity, Health, Transportation, and Land Use.
Handy, Susan L., Yan Xing, and Theodore J. Buehler. 2010. “Factors Associated with Bicycle Ownership and Use: A Study of Six Small US Cities.” *Transportation* 37 (6): 967–85.
Helveston, John Paul, Yimin Liu, Elea McDonnell Feit, Erica Fuchs, Erica Klampfl, and Jeremy J. Michalek. 2015. “Will Subsidies Drive Electric Vehicle Adoption? Measuring Consumer Preferences in the US and China.” *Transportation Research Part A: Policy and Practice* 73: 96–112.
Hogan, Howard, Deborah Perez, and William Bell. 2008. “Who (Really) Are the First Baby Boomers?” In *Joint Statistical Meetings Proceedings, Social Statistics Section*, 1009–1016. Alexandria, VA.
Hohenberger, Christoph, Matthias Spörrle, and Isabell M. Welpe. 2016. “How and Why Do Men and Women Differ in Their Willingness to Use Automated Cars? The Influence of Emotions across Different Age Groups.” *Transportation Research Part A: Policy and Practice* 94: 374–85.
Holmes, M., S. Sarkar, M. Emami, and D. Shaules. 2002. “Travel Patterns and Concerns of Suburban Elderly in San Diego County.” In . Washington D.C.
Hu, Patricia S., and Timothy R. Reuscher. 2004. “Summary of Travel Trends: 2001 National Household Travel Survey.” U.S. Department of Transportation, Federal Highway Administration. https://nhts.ornl.gov/2001/pub/STT.pdf.
Ipeirotis, Panos. 2015. “Demographics of Mechanical Turk (April 2015 Edition).” 2015. http://www.behind-the-enemy-lines.com/2015/04/demographics-of-mechanical-turk-now.html.
Jia, Ning, Yidan Zhang, Zhengbing He, and Geng Li. 2017. “Commuters’ Acceptance of and Behavior Reactions to License Plate Restriction Policy: A Case Study of Tianjin, China.” *Transportation Research Part D: Transport and Environment* 52: 428–40.

Jiang, Kang, Feiyang Ling, Zhongxiang Feng, Kun Wang, and Cheng Shao. 2017. "Why Do Drivers Continue Driving While Fatigued? An Application of the Theory of Planned Behaviour." *Transportation Research Part A: Policy and Practice* 98: 141–49.

Jones, Andrew P., Emma G. Coombes, Simon J. Griffin, and Esther MF van Sluijs. 2009. "Environmental Supportiveness for Physical Activity in English Schoolchildren: A Study Using Global Positioning Systems." *International Journal of Behavioral Nutrition and Physical Activity* 6 (1): 42.

Kang, Bumjoon, Anne V. Moudon, Philip M. Hurvitz, and Brian E. Saelens. 2017. "Differences in Behavior, Time, Location, and Built Environment between Objectively Measured Utilitarian and Recreational Walking." *Transportation Research Part D: Transport and Environment* 57: 185–94.

Karlsson, Sten. 2017. "What Are the Value and Implications of Two-Car Households for the Electric Car?" *Transportation Research Part C: Emerging Technologies* 81: 1–17.

Khattak, Asad J., Frank S. Koppelman, and Joseph L. Schofer. 1993. "Stated Preferences for Investigating Commuters' Diversion Propensity." *Transportation* 20 (2): 107–27.

Khattak, Asad J., and Daniel Rodriguez. 2005. "Travel Behavior in Neo-Traditional Neighborhood Developments: A Case Study in USA." *Transportation Research Part A: Policy and Practice* 39 (6): 481–500.

King, Abby C., Dan Stokols, Emily Talen, Glenn S. Brassington, and Richard Killingsworth. 2002. "Theoretical Approaches to the Promotion of Physical Activity: Forging a Transdisciplinary Paradigm." *American Journal of Preventive Medicine* 23 (2): 15–25.

Kochera, Andrew, Audrey Straight, and Thomas Guterbock. 2005. "Beyond 50.05: A Report to the Nation on Livable Communities-Creating Environments for Successful Aging." AARP. https://assets.aarp.org/rgcenter/il/beyond_50_communities.pdf.

Krupa, Joseph S., Donna M. Rizzo, Margaret J. Eppstein, D. Brad Lanute, Diann E. Gaalema, Kiran Lakkaraju, and Christina E. Warrender. 2014. "Analysis of a Consumer Survey on Plug-in Hybrid Electric Vehicles." *Transportation Research Part A: Policy and Practice* 64: 14–31.

Lee, Chaiwoo. 2014. "User-Centered System Design in an Aging Society: An Integrated Study on Technology Adoption." Massachusetts Institute of Technology.

Lee, Loretta T., Pamela G. Bowen, Michael K. Mosley, and Carla C. Turner. 2017. "Theory of Planned Behavior: Social Support and Diabetes Self-Management." *The Journal for Nurse Practitioners* 13 (4): 265–70.

Leonesio, Michael V., Benjamin Bridges, Robert Gesumaria, and Linda Del Bene. 2012. "The Increasing Labor Force Participation of Older Workers and Its Effect on the Income of the Aged." *Soc. Sec. Bull.* 72: 59.

Li, Pengfei, Jianjun Shi, Xiaoming Liu, and Haizhong Wang. 2016. "The Theory of Planned Behavior and Competitive Driving in China." *Procedia Engineering* 137: 362–71.

Lima, Jessica de, M. Leonor Maia, and Karen Lucas. 2017. “Income vs. Travel Time: Why Do the Poorest and the Richest Travel Fastest in Northeastern Brazil?” *Transportation Research Procedia* 25: 4289–99.

Lipsey, Mark W., and David B. Wilson. 1993. “The Efficacy of Psychological, Educational, and Behavioral Treatment: Confirmation from Meta-Analysis.” *American Psychologist* 48 (12): 1181.

Maguire, Tom. 2017. “2017 Transportation Decision Survey: Alternatives for a Safer, More Sustainable Future.” Text. SFMTA. October 13, 2017. https://www.sfmta.com/blog/2017-transportation-decision-survey-alternatives-safer-more-sustainable-future.

Mancha, Ruben M., and Carol Y. Yoder. 2015. “Cultural Antecedents of Green Behavioral Intent: An Environmental Theory of Planned Behavior.” *Journal of Environmental Psychology* 43: 145–54.

Mason, Winter, and Siddharth Suri. 2012. “Conducting Behavioral Research on Amazon’s Mechanical Turk.” *Behavior Research Methods* 44 (1): 1–23.

Mattson, Jeremy. 2011. “Transportation, Distance, and Health Care Utilization for Older Adults in Rural and Small Urban Areas.” *Transportation Research Record* 2265 (1): 192–99.

McDonald, Noreen C., Yizhao Yang, Steve M. Abbott, and Allison N. Bullock. 2013. “Impact of the Safe Routes to School Program on Walking and Biking: Eugene, Oregon Study.” *Transport Policy* 29: 243–48.

McLeroy, Kenneth R., Daniel Bibeau, Allan Steckler, and Karen Glanz. 1988. “An Ecological Perspective on Health Promotion Programs.” *Health Education Quarterly* 15 (4): 351–77.

nadtc. 2018. “Transportation: Aging & Disability.” National Aging and Disability Transportation Center. 2018. https://www.nadtc.org/about/transportation-aging-disability/.

National Research Council (US). 2005. *Does the Built Environment Influence Physical Activity?: Examining the Evidence--Special Report 282*. Transportation Research Board.

Ortman, Jennifer M., Victoria A. Velkoff, and Howard Hogan. 2014. “An Aging Nation: The Older Population in the United States.” P25-1140. Current Population Reports. U.S. Census Bureau. https://www.census.gov/prod/2014pubs/p25-1140.pdf.

Oztekin, Ceren, Gaye Teksöz, Savas Pamuk, Elvan Sahin, and Dilek Sultan Kilic. 2017. “Gender Perspective on the Factors Predicting Recycling Behavior: Implications from the Theory of Planned Behavior.” *Waste Management* 62: 290–302.

Pan, Jing Yu, and Dothang Truong. 2018. “Passengers’ Intentions to Use Low-Cost Carriers: An Extended Theory of Planned Behavior Model.” *Journal of Air Transport Management* 69: 38–48.

Pan, Xiaohong. 2012. “Senior Population’s Transportation Preferences to Access Health Care Services – Insights from the 2009 National Household Travel Survey (NHTS).” In . Washington D.C.

Paolacci, Gabriele, and Jesse Chandler. 2014. “Inside the Turk: Understanding Mechanical Turk as a Participant Pool.” *Current Directions in Psychological Science* 23 (3): 184–88.

Paolacci, Gabriele, Jesse Chandler, and Panagiotis G. Ipeirotis. 2010. "Running Experiments on Amazon Mechanical Turk." *Judgment and Decision Making* 5 (5): 411–19.

Pookulangara, Sanjukta, Jana Hawley, and Ge Xiao. 2011. "Explaining Consumers' Channel-Switching Behavior Using the Theory of Planned Behavior." *Journal of Retailing and Consumer Services* 18 (4): 311–21.

Potard, C., V. Kubiszewski, G. Camus, R. Courtois, and S. Gaymard. 2018. "Driving under the Influence of Alcohol and Perceived Invulnerability among Young Adults: An Extension of the Theory of Planned Behavior." *Transportation Research Part F: Traffic Psychology and Behaviour* 55: 38–46.

Prat, F., M. E. Gras, M. Planes, S. Font-Mayolas, and M. J. M. Sullman. 2017. "Driving Distractions: An Insight Gained from Roadside Interviews on Their Prevalence and Factors Associated with Driver Distraction." *Transportation Research Part F: Traffic Psychology and Behaviour* 45: 194–207.

PSRC. 2016. "Travel Surveys: 2006 Household Activity Survey." Puget Sound Regional Council. November 18, 2016. https://www.psrc.org/travel-surveys-2006-household-activity-survey.

———. 2017a. "Household Travel Survey Program." Puget Sound Regional Council. March 30, 2017. https://www.psrc.org/household-travel-survey-program.

———. 2017b. "Travel Surveys: Spring 2015 Household Survey." Puget Sound Regional Council. March 30, 2017. https://www.psrc.org/travel-surveys-2015-household-survey.

Raftery, Adrian E. 1995. "Bayesian Model Selection in Social Research." *Sociological Methodology*, 111–63.

Rand, David G. 2012. "The Promise of Mechanical Turk: How Online Labor Markets Can Help Theorists Run Behavioral Experiments." *Journal of Theoretical Biology* 299: 172–79.

Rashidi, Taha H., Alireza Abbasi, Mojtaba Maghrebi, Samiul Hasan, and Travis S. Waller. 2017. "Exploring the Capacity of Social Media Data for Modelling Travel Behaviour: Opportunities and Challenges." *Transportation Research Part C: Emerging Technologies* 75: 197–211.

Rodriguez, Daniel A., and Joonwon Joo. 2004. "The Relationship between Non-Motorized Mode Choice and the Local Physical Environment." *Transportation Research Part D: Transport and Environment* 9 (2): 151–73.

Rosenbloom, Sandra. 2001. "Sustainability and Automobility among the Elderly: An International Assessment." *Transportation* 28 (4): 375–408.

RSG. 2015. "Puget Sound Regional Travel Study Report: 2015 Household Travel Survey." RSG. https://www.psrc.org/sites/default/files/2015-household-survey-tech-report.pdf.

Sallis, James F., Myron F. Floyd, Daniel A. Rodríguez, and Brian E. Saelens. 2012. "Role of Built Environments in Physical Activity, Obesity, and Cardiovascular Disease." *Circulation* 125 (5): 729–37.

Sallis, James F., and Neville Owen. 2008. "Ecological Models of Health Behavior." In *Health Behavior and Health Education: Theory, Research, and Practice*. John Wiley & Sons.

Schwanen, Tim, and Antonio Páez. 2010. “The Mobility of Older People: An Introduction.” *Journal of Transport Geography* 18 (5): 591–95.
SFMTA. 2013. “The FY 2013 - FY 2018 SFMTA Strategic Plan.” SFMTA. https://www.sfmta.com/sites/default/files/FY%202013%20-%20FY%202018%20SFMTA%20Strategic%20Plan.pdf.
———. 2017. “Travel Decision Survey 2017.” Text. SFMTA. October 18, 2017. https://www.sfmta.com/reports/travel-decision-survey-2017.
Simons, Daniel J., and Christopher F. Chabris. 2012. “Common (Mis) Beliefs about Memory: A Replication and Comparison of Telephone and Mechanical Turk Survey Methods.” *PloS One* 7 (12): e51876.
Siren, Anu, and Sonja Haustein. 2016. “How Do Baby Boomers’ Mobility Patterns Change with Retirement?” *Ageing & Society* 36 (5): 988–1007.
Song, Yena, John Preston, David Ogilvie, and iConnect consortium. 2017. “New Walking and Cycling Infrastructure and Modal Shift in the UK: A Quasi-Experimental Panel Study.” *Transportation Research Part A: Policy and Practice* 95: 320–33.
St Louis, Renée M., Nicole Zanier, Lisa J. Molnar, and David W. Eby. 2011. “Transportation in Michigan: Older Adults and Caregivers.” project number OR09102. Michigan Department of Transportation, Office of Research and Best Practices. https://deepblue.lib.umich.edu/bitstream/handle/2027.42/90963/102858.pdf?sequence=1.
Stern, Steven. 1993. “A Disaggregate Discrete Choice Model of Transportation Demand by Elderly and Disabled People in Rural Virginia.” *Transportation Research Part A: Policy and Practice* 27 (4): 315–27.
Susilo, Yusak O., Andree Woodcock, Fotis Liotopoulos, Andre Duarte, Jane Osmond, Roberto F. Abenoza, Lucian Emanuel Anghel, Dolores Herrero, Federico Fornari, and Virginie Tolio. 2017. “Deploying Traditional and Smartphone App Survey Methods in Measuring Door-to-Door Travel Satisfaction in Eight European Cities.” *Transportation Research Procedia* 25: 2257–75.
Tan, Chin-Seang, Hooi-Yin Ooi, and Yen-Nee Goh. 2017. “A Moral Extension of the Theory of Planned Behavior to Predict Consumers’ Purchase Intention for Energy-Efficient Household Appliances in Malaysia.” *Energy Policy* 107: 459–71.
The TurkPrime Team. n.d. “The New New Demographics on Mechanical Turk: Is There Still a Gender Gap?” Accessed September 2, 2018. http://blog.turkprime.com/2015/03/the-new-new-demographics-on-mechanical.html.
Thøgersen-Ntoumani, C. 2009. “An Ecological Model of Predictors of Stages of Change for Physical Activity in Greek Older Adults.” *Scandinavian Journal of Medicine & Science in Sports* 19 (2): 286–96.
Thorhauge, Mikkel, Sonja Haustein, and Elisabetta Cherchi. 2016. “Accounting for the Theory of Planned Behaviour in Departure Time Choice.” *Transportation Research Part F: Traffic Psychology and Behaviour* 38: 94–105.

Transportation Research Board. 2016. “Exploring New Directions for the National Household Travel Survey.” Transportation Research Board E-Circular 217. Transportation Research Board.
Travel Survey Methods Committee. 2016. “Travel Survey ManualChapter 3.” http://www.travelsurveymanual.org/Chapter-3-1.html.
UCLA IDRE. n.d. “Introduction to Power Analysis.” Accessed September 2, 2018. https://stats.idre.ucla.edu/other/mult-pkg/seminars/intro-power/.
Warner, Henriette Wallén, and Lars Åberg. 2006. “Drivers’ Decision to Speed: A Study Inspired by the Theory of Planned Behavior.” *Transportation Research Part F: Traffic Psychology and Behaviour* 9 (6): 427–33.
Werneke, Julia, Marco Dozza, and MariAnne Karlsson. 2015. “Safety–Critical Events in Everyday Cycling–Interviews with Bicyclists and Video Annotation of Safety–Critical Events in a Naturalistic Cycling Study.” *Transportation Research Part F: Traffic Psychology and Behaviour* 35: 199–212.
West, Loraine A., Samantha Cole, Daniel Goodkind, and Wan He. 2014. “65+ in the United States: 2010.” Current Population Reports. P23-212. U.S. Census Bureau.
WHCOA. 2005. “The Booming Dynamics of Aging: From Awareness to Action.” In *Final Report of 2005 White House Conference on Aging*. Washington, D.C.
Winch, Peter. 2011. “Ecological Models and Multilevel Interventions. Health Behavior Change at the Individual, Household and Community Levels.” 2011. http://ocw.jhsph.edu/courses/healthbehaviorchange/PDFs/C14_2011.pdf.
Xing, Yan, Susan L. Handy, and Patricia L. Mokhtarian. 2010. “Factors Associated with Proportions and Miles of Bicycling for Transportation and Recreation in Six Small US Cities.” *Transportation Research Part D: Transport and Environment* 15 (2): 73–81.
Zhang, Zhenhua, Qing He, and Shanjiang Zhu. 2017. “Potentials of Using Social Media to Infer the Longitudinal Travel Behavior: A Sequential Model-Based Clustering Method.” *Transportation Research Part C: Emerging Technologies* 85: 396–414.
Zhou, Hongmei, Stephanie Ballon Romero, and Xiao Qin. 2016. “An Extension of the Theory of Planned Behavior to Predict Pedestrians’ Violating Crossing Behavior Using Structural Equation Modeling.” *Accident Analysis & Prevention* 95: 417–24.

Appendix A: Additional Results on Descriptive Statistics and Logistic Regression

Table A.1. Descriptive Statistics of Independent Variables

Variable – descriptive measure	Seniors (> 64)	Middle-aged boomers (45 – 64)	Younger generations (< 45)
Socio-demographic characteristics			
Age – mean	74.66	54.22	25.25
Female (vs. male) – percentage	57.65%	51.18%	49.02%
Household size – mean	1.98	2.61	3.93
Home rented (vs. home owned) – percentage	27.09%	23.70%	32.18%
N for age, female, household size, and home rented	86,112	112,402	110,387
Income (derived) – mean	$40,737	$63,872	$63,384
N for income	76,559	105,637	106,147
Working (yes vs. no) – percentage	21.28%	73.08%	70.97%
N for working	86,071	112,321	72,165
Built environment factors			
Population density (population per sq. mile) – mean	4627.85	4811.04	5172.62
N for population density	289,162	462,120	416,037
Employment density (employment per sq. mile) – mean	1206.01	1230.44	1215.71
N for employment density	289,162	462,115	416,032
Urban size – mode	non-urbanized area		
N for urban size	289,162	462,120	416,037
Transportation attributes			
Household car ownership – mean	1.74	2.31	2.31
N for household car ownership	289,162	462,122	416,037
Number of drivers in household – mean	1.65	2.09	2.24
N for number of drivers in household	289,162	462,122	416,037
Additional household member on trip (vs. none) – percentage	30.98%	26.93%	44.89%
N for additional household member on trip	286,214	456,727	396,238
Travel time (mins) – mean	19.45	20.67	20.06
N for travel time	288,014	461,316	415,037
Behavioral aspects (most important transportation issue)			
Cost (yes vs. no) – percentage	34.34%	35.33%	39.31%
Congestion (yes vs. no) – percentage	14.74%	16.59%	13.86%
Aggressive Drivers (yes vs. no) – percentage	17.48%	19.07%	16.26%
Safety (yes vs. no) – percentage	20.77%	17.83%	17.97%
Transit access (yes vs. no) – percentage	6.37%	7.47%	7.60%
Sidewalks (yes vs. no) – percentage	2.59%	2.62%	4.19%
N for behavioral aspects	251,880	402,210	234,584

Table A.2. Logistic Regression Results of Mode Choice on Travels for Daily Needs

Variable	Odds ratio for different age groups		
	Seniors (> 64)	Middle-aged boomers (45 – 64)	Younger generations (< 45)
Socio-demographic characteristics			
Age	1.02080***	1.01148*	1.01074**
Female (vs. male)	1.35934***	1.26918***	1.10683
Household size[+]	0.26461***	0.47627***	0.53789***
Home rented (vs. home owned)	0.83635	0.84784**	0.88908
Income[+]	0.97008	1.03810*	1.02706
Working	1.06222	1.06354	1.51951***
Built environment factors			
Population density	0.99995***	0.99995***	0.99994***
Employment density	0.99985***	0.99991***	0.99991***
Urban size 1 (200,000-499,999) [++]	1.08167	1.24453	0.91311
Urban size 2 (500,000-999,999) [++]	1.22360	1.30179*	0.93196
Urban size 3 (1 million or more w/o subway/ rail) [++]	1.76828***	1.36175**	0.84593
Urban size 4 (1 million or more w subway/ rail) [++]	1.17419	1.02646	0.66613***
Urban size 5 (non-urbanized area) [++]	0.87304	1.10867	0.76635*
Transportation attributes			
Household car ownership	1.93626***	1.23507***	1.35106***
Number of drivers in household	1.14793	1.25887***	1.18620**
Additional household member on trip (vs. none)	18.88393***	11.74199***	14.15959***
Travel time[+]	1.00566	0.83074***	0.92732**
Behavioral aspects (most important transportation issue)			
Cost	2.21552***	1.11902	1.37707
Congestion	2.34340***	1.34662	1.79378**
Aggressive Drivers	2.49627***	1.48213*	1.66779**
Safety	2.57367***	1.39116	1.88121**
Transit access	1.03809	0.48463***	0.86586
Sidewalks	0.96288	0.42423***	0.81001
Constant	0.56108	1.73572	1.52686
N	112,414	155,193	81,329

Note: odds ratio = exp (coefficient); *** p≤ 0.01; ** p≤ 0.05; * p≤ 0.1; [+] these independent variables (i.e., household size, income, and travel time) are taken natural log transformation in the analysis due to their positively skewed distributions; [++] residence in a urban area of at least 50,000 and less than 199,999 people is set as a reference group when generating categorical variables for the urban size variable, where living in urban area of at least 200,000 and less than 499,999 people, urban area of at least 500,000 and less than 999,999 people, urban area of 1 million or more people without subway or rail, urban area of 1 million or more people with subway or rail, or non-urbanized area is each compared to the reference group in the logit model.

Table A.3. Logistic Regression Results of Mode Choice on the First Daily-Needs Trip of the Day

Variable	Odds ratio for different age groups		
	Seniors (> 64)	Middle-aged boomers (45 – 64)	Younger generations (< 45)
Socio-demographic characteristics			
Age	1.01714**	1.01487*	1.01010
Female (vs. male)	1.19378*	1.17728*	0.89669
Household size[+]	0.18320***	0.35619***	0.42402***
Home rented (vs. home owned)	0.92890	0.82158	0.98174
Income[+]	0.96651	1.05035***	1.02217
Working	1.16406	1.19748*	1.86420***
Built environment factors			
Population density	0.99995***	0.99996***	0.99994***
Employment density	0.99991**	0.99989***	0.99985***
Urban size 1 (200,000-499,999) [++]	1.07047	1.26046	0.62950
Urban size 2 (500,000-999,999) [++]	1.24147	1.08703	0.62307
Urban size 3 (1 million or more w/o subway/ rail) [++]	1.37020*	0.96863	0.57384**
Urban size 4 (1 million or more w subway/ rail) [++]	1.06222	0.91930	0.45156***
Urban size 5 (non-urbanized area) [++]	0.88443	1.04478	0.58951*
Transportation attributes			
Household car ownership	2.19770***	1.58909***	1.36959***
Number of drivers in household	1.16601	1.15393	1.39418***
Additional household member on trip (vs. none)	26.12201***	15.67583***	22.06373***
Travel time[+]	0.91505	0.73030***	0.82485***
Behavioral aspects (most important transportation issue)			
Cost	2.08428***	1.57308*	1.15757
Congestion	1.75311**	1.53782	2.26807*
Aggressive Drivers	2.06305***	1.62656	1.07058
Safety	1.88203**	1.76877*	1.71115
Transit access	0.83370	0.62387**	0.88516
Sidewalks	0.78045	0.49830*	0.68973
Constant	1.01940	1.41425	2.87643
N	34,284	36,756	18,015

Note: odds ratio = exp (coefficient); *** p≤ 0.01; ** p≤ 0.05; * p≤ 0.1; [+] these independent variables (i.e., household size, income, and travel time) are taken natural log transformation in the analysis due to their positively skewed distributions; [++] residence in a urban area of at least 50,000 and less than 199,999 people is set as a reference group when generating categorical variables for the urban size variable, where living in urban area of at least 200,000 and less than 499,999 people, urban area of at least 500,000 and less than 999,999 people, urban area of 1 million or more people without subway or rail, urban area of 1 million or more people with subway or rail, or non-urbanized area is each compared to the reference group in the logit model.

Appendix B: Survey on Senior Transportation Options

The self-designed survey was developed in the Qualtrics survey software and implemented on the web-based Amazon Mechanical Turk platform. The following survey questionnaire has been slightly re-organized for presentation purpose, based on different types of users of senior transportation services.

Q1 Survey on Senior Transportation Options

Q2 Getting older? Being a caregiver of older persons? Thinking of transportation options when you become old? We welcome your thoughts on transportation options for aging populations. In this survey, you will be asked to express your opinions on senior transportation. The estimated time to complete the survey is about 5-10 minutes. At the end of the survey, you will receive a confirmation code. Bring this code back to your Amazon Mechanical Turk page, and you will be paid $0.75. This survey involves minimal risk to you. You have the right to withdraw your consent or discontinue participation at any time. Participation is entirely voluntary and you may refuse to participate, withdraw consent, or discontinue participation at any time without penalty. We will not ask for any personally identifying information (e.g., your name) and all data will be kept confidential.

Q167 If you agree to participate in this survey, please type "I agree" in the space provided.

Q3 How old are you?
- ❍ Less than 18 (1)
- ❍ 18 - 24 (2)
- ❍ 25 - 34 (3)
- ❍ 35 - 44 (4)
- ❍ 45 - 54 (5)
- ❍ 55 - 64 (6)
- ❍ 65 - 74 (7)
- ❍ 75 - 84 (8)
- ❍ 85 + (9)

(For Type 1 Survey Respondents: Seniors – who answered in Q3 that they are 65 years and older)

Q4 Living Environment

Q5 Which best describes the place you live?
- ❍ Urban area (1)
- ❍ Suburban area (2)
- ❍ Rural area (3)

Q6 Approximately, how far is your home away from shopping areas (e.g., restaurants, grocery stores, pharmacies)?
- ❍ Less than 1/2 mile (i.e., within walking distance) (1)
- ❍ 1/2 - 5 miles (2)
- ❍ 5 - 10 miles (3)
- ❍ Greater than 10 miles (4)

Q7 Approximately, how far is your home away from healthcare facilities (e.g., doctor offices, hospitals)?
- Less than 1/2 mile (i.e., within walking distance) (1)
- 1/2 - 5 miles (2)
- 5 - 10 miles (3)
- Greater than 10 miles (4)

Q8 Approximately, how far is your home away from recreational areas or social places (e.g., parks, YMCAs, community centers)?
- Less than 1/2 mile (i.e., within walking distance) (1)
- 1/2 - 5 miles (2)
- 5 - 10 miles (3)
- Greater than 10 miles (4)

Q9 What is the ZIP Code for where your home is located?

Q170 Is your home a house, an apartment, or some other type of residence?
- House (1)
- Apartment (2)
- Other (3) _____

Q10 Is your home owned or rented?
- Owned (1)
- Rented (2)
- Other (3) _____

Q11 Including yourself, how many people live in your household?
- 1 (1)
- 2 (2)
- 3 (3)
- 4 (4)
- 5 (5)
- More Than 5 (6)

Answer If Including yourself, how many people live in your household? 1 Is Not Selected

Q180 Including yourself, how many household members are 65 years old and over?
- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- More Than 4 (6)

Q12 Are you planning to live in the home as long as you can?
- Yes (1)
- No (2)

Q13 Still Working?

Q14 Are you still participating in workforce?
- ❍ Full time (1)
- ❍ Part time (2)
- ❍ Retired (3)
- ❍ Other (4) _____

Answer If Are you still participating in workforce? Full time Is Selected Or Are you still participating in workforce? Part time Is Selected

Q15 When are you planning to retire?
- ❍ In less than 5 years (1)
- ❍ In 5 - 10 years (2)
- ❍ Over 10 years (3)

Q16 Still Driving?

Q17 Do you still drive?
- ❍ Yes, I drive regularly. (1)
- ❍ Yes, but I only drive very occasionally. (3)
- ❍ No. (2)

Answer If Do you still drive? No. Is Not Selected

Q18 When are you planning to cease driving?
- ❍ In less than 5 years (1)
- ❍ In 5 - 10 years (2)
- ❍ Over 10 years (3)

Answer If Are you still a driver? No Is Selected

Q19 Have you ever had a diver license before?
- ❍ Yes (1)
- ❍ No (2)

Q20 Transportation Reality

Q173 What travel options have you used in the past year? (check all options that apply to you)
- ❑ Walk (1)
- ❑ By bike (2)
- ❑ By private car - as a driver (3)
- ❑ By private car - as a passenger (4)
- ❑ By public transit - train (5)
- ❑ By public transit - bus (6)
- ❑ By public transit - paratransit/demand response services (7)
- ❑ By traditional taxi services (8)
- ❑ By new "taxi" services (e.g., Uber, Lyft, Sidecar) (9)
- ❑ Other (10) _____

Q23 Transportation Reality

Q21 On average, how often do you go out for dining, shopping, health care, recreation, or social events?
- More than twice everyday (1)
- Once or twice everyday (2)
- 3-5 times every week (3)
- Once or twice every week (4)
- Less than once every week (5)

Q22 On average, how long do these trips take you to travel one way?
- Less than 10 minutes (1)
- 10-30 minutes (2)
- More than 30 minutes (3)

Q24 When you go out for these trips, what travel option do you use the most?
- Walk (1)
- By bike (2)
- By private car - as a driver (3)
- By private car - as a passenger (4)
- By public transit - train (5)
- By public transit - bus (6)
- By public transit - paratransit/demand response services (7)
- By traditional taxi services (8)
- By new "taxi" services (e.g., Uber, Lyft, Sidecar) (9)
- Other (10) _____

Q25 I pick the above mentioned travel option because I don't have other feasible transportation options.
- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

Q27 I pick the above mentioned travel option because it's more convenient.
- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

Q28 I pick the above mentioned travel option because of my own preference.
- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

Q29 I pick the above mentioned travel option because it helps me to maintain independence.
- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

Q30 I pick the above mentioned travel option because my friends and neighbors use the same option for travel as well.
- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

Q31 I pick the above mentioned travel option because it's less expensive.
- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

Q32 Please list other factors that may affect your travel mode choices:

Q97 Transportation Reality

Q33 Have you used any home delivery service (e.g., from a local grocery/drug store or online shopping)?
- Yes (1)
- No (2)

If No Is Selected, Then Skip To End of Block

Q34 How do you order your delivery services? (check all options that apply to you)
- ❑ Home phone (1)
- ❑ Cell phone (2)
- ❑ Internet (3)
- ❑ Other (4) _____

Q35 How often do you use delivery services?
- ❍ Every week (1)
- ❍ Every other week (2)
- ❍ Every month (3)
- ❍ Occasionally (4)

Q36 Have these deliveries changed or substituted your own travel?
- ❍ Yes, I make fewer total trips myself. (1)
- ❍ Yes, I make fewer shopping trips but about the same number of total trips. (2)
- ❍ No, I make same number of trips as before. (3)

Q37 Preferences on Transportation Options

Q38 If I ever need any help on transportation access, I prefer supports from neighbors/community centers (e.g., local YMCA/senior center shuttle services).
- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Somewhat Disagree (3)
- ❍ Neither Agree nor Disagree (4)
- ❍ Somewhat Agree (5)
- ❍ Agree (6)
- ❍ Strongly Agree (7)

Q39 If I ever need any help on transportation access, I prefer supports from public agencies (e.g., local transit agency).
- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Somewhat Disagree (3)
- ❍ Neither Agree nor Disagree (4)
- ❍ Somewhat Agree (5)
- ❍ Agree (6)
- ❍ Strongly Agree (7)

Q40 If I ever need any help on transportation access, I prefer supports from private services (e.g., taxi or Uber services).
- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Somewhat Disagree (3)
- ❍ Neither Agree nor Disagree (4)
- ❍ Somewhat Agree (5)
- ❍ Agree (6)
- ❍ Strongly Agree (7)

Q41 If I ever need any help on transportation access, I prefer supports from family members/friends.
- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

Q177 If better transportation services are provided, I'd like to go out more often for dining, shopping, health care, recreation, or social events.
- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

Q42 Have you worried about your transportation options before?
- No. (1)
- Yes, less than 5 years ago. (2)
- Yes, 5-10 years ago. (3)
- Yes, over 10 years ago. (4)

Q43 Any additional comments on this topic of senior transportation options?

Q44 Attitudes towards New Transportation Options

Q46 If neighbors/community centers inform me about NEW transportation options (e.g., new shuttle services provided by local senior center, new bus lines provided by public transit agency, or new private services specialized for seniors), I'd like to try/use them.
- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

Q47 If public agencies inform me about NEW transportation options (e.g., new shuttle services provided by local senior center, new bus lines provided by public transit agency, or new private services specialized for seniors), I'd like to try/use them.
- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

Q48 If private companies/commercial advertisements inform me about NEW transportation options (e.g., new shuttle services provided by local senior center, new bus lines provided by public transit agency, or new private services specialized for seniors), I'd like to try/use them.

- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Somewhat Disagree (3)
- ❍ Neither Agree nor Disagree (4)
- ❍ Somewhat Agree (5)
- ❍ Agree (6)
- ❍ Strongly Agree (7)

Q49 If family members/friends inform me about NEW transportation options (e.g., new shuttle services provided by local senior center, new bus lines provided by public transit agency, or new private services specialized for seniors), I'd like to try/use them.

- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Somewhat Disagree (3)
- ❍ Neither Agree nor Disagree (4)
- ❍ Somewhat Agree (5)
- ❍ Agree (6)
- ❍ Strongly Agree (7)

Q50 Perceived Health Status

Q51 In general, my health is very good.

- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Somewhat Disagree (3)
- ❍ Neither Agree nor Disagree (4)
- ❍ Somewhat Agree (5)
- ❍ Agree (6)
- ❍ Strongly Agree (7)

Q52 What health insurance plans do you have?

- ☐ Medicare (1)
- ☐ Medicaid (2)
- ☐ Commercial/private insurance (3)
- ☐ Self-pay (4)
- ☐ Other (5) _____

Q53 My current transportation options have become barriers for my visits to doctor or medical treatment.

- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Somewhat Disagree (3)
- ❍ Neither Agree nor Disagree (4)
- ❍ Somewhat Agree (5)
- ❍ Agree (6)
- ❍ Strongly Agree (7)

Q54 Demographics

Q55 What is your sex?
- ❍ Male (1)
- ❍ Female (2)

Q56 Which best describes your race?
- ❑ White (1)
- ❑ African American (2)
- ❑ Hispanic (3)
- ❑ Asian or Pacific Islander (4)
- ❑ Native American (5)
- ❑ Other (6) _____

Q57 What's your total household income?
- ❍ Less than 10,000 (1)
- ❍ 10,000 - 19,999 (2)
- ❍ 20,000 - 29,999 (3)
- ❍ 30,000 - 39,999 (4)
- ❍ 40,000 - 49,999 (5)
- ❍ 50,000 - 59,999 (6)
- ❍ 60,000 - 69,999 (7)
- ❍ 70,000 - 79,999 (8)
- ❍ 80,000 - 89,999 (9)
- ❍ 90,000 - 99,999 (10)
- ❍ 100,000 - 149,999 (11)
- ❍ More than 150,000 (12)
- ❍ I prefer not to answer (13)

Q58 What is the highest grade or year of school you have completed?
- ❍ Less Than High School Graduate (1)
- ❍ High School Graduate or GED (2)
- ❍ Some College or Associate's Degree (3)
- ❍ Bachelor's Degree (4)
- ❍ Post Graduate Degree (Master's, PhD, MD, JD etc) (5)
- ❍ Other (6) _____

(For Type 2 Survey Respondents: Caregivers and their Elderly Dependents – who answered in Q3 that they are younger than 65 years and in Q60 that they are caregivers of an elderly dependent and in Q61 that their elderly dependent does not live in an institutional care facility)

Q59 Caregiver?

Q60 Are you a caregiver of an elderly dependent who is 65 years old and over?
- ❍ Yes (1)
- ❍ No (2)

Answer If Are you a caregiver of an elderly dependent? Yes Is Selected

Q61 Does your elderly dependent live in an institutional care facility (e.g., nursing home)?
- ❍ Yes (1)
- ❍ No (2)

Q183 Caregiver and Elderly Dependent

Q186 Are you participating in workforce?
- ❍ Full time (1)
- ❍ Part time (2)
- ❍ No (3)
- ❍ Other (4) _____

Q187 Does your elderly dependent need your help with transportation?
- ❑ Yes, I need to arrange a transportation service for my elderly dependent. (1)
- ❑ Yes, I need to assist my elderly dependent on travel by myself. (2)
- ❑ No. (3)

If No. Is Selected, Then Skip To End of Block

Answer If Does your elderly dependent need your help on transportation? Yes, I need to arrange a transportation service for my elderly dependent. Is Selected

Q188 What type of transportation services do you use most often for your elderly dependent?
- ❑ Community based services (e.g., local YMCA/senior center shuttle services) (1)
- ❑ Services from public agencies (e.g., local transit agency) (2)
- ❑ Services from private services (e.g., taxi or Uber services) (3)
- ❑ Help from relatives/friends (4)
- ❑ Other (5) _____

Q189 How often your elderly dependent need your help on transportation access?
- ❍ Very often (1)
- ❍ Sometimes (2)
- ❍ Occasionally (3)
- ❍ Other (4) _____

Q190 It's convenient for me to help my elderly dependent on transportation access.
- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Somewhat Disagree (3)
- ❍ Neither Agree nor Disagree (4)
- ❍ Somewhat Agree (5)
- ❍ Agree (6)
- ❍ Strongly Agree (7)

Q72 Elderly Dependent: Living Environment

Q73 Which best describes the place your elderly dependent lives?
- ❍ Urban area (1)
- ❍ Suburban area (2)
- ❍ Rural area (3)

Q74 Approximately, how far is his/her home away from shopping areas (e.g., restaurants, grocery stores, pharmacies)?
- Less than 1/2 mile (i.e., within walking distance) (1)
- 1/2 - 5 miles (2)
- 5 - 10 miles (3)
- Greater than 10 miles (4)

Q75 Approximately, how far is his/her home away from healthcare facilities (e.g., doctor offices, hospitals)?
- Less than 1/2 mile (i.e., within walking distance) (1)
- 1/2 - 5 miles (2)
- 5 - 10 miles (3)
- Greater than 10 miles (4)

Q76 Approximately, how far is his/her home away from recreational areas or social places (e.g., parks, YMCAs, community centers)?
- Less than 1/2 mile (i.e., within walking distance) (1)
- 1/2 - 5 miles (2)
- 5 - 10 miles (3)
- Greater than 10 miles (4)

Q77 What is the ZIP Code for where your elderly dependent lives?

Q169 Is your elderly dependent's home a house, an apartment, or some other type of residence?
- House (1)
- Apartment (2)
- Other (3) _____

Q78 Is his/her home owned or rented?
- Owned (1)
- Rented (2)
- Other (3) _____

Q79 Including your elderly dependent, how many people live in his/her household?
- 1 (1)
- 2 (2)
- 3 (3)
- 4 (4)
- 5 (5)
- More Than 5 (6)

Answer If Including your elderly dependent, how many people live in his/her household? 1 Is Not Selected

Q179 Including your elderly dependent, how many household members are 65 years old and over?
- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- More Than 4 (6)

Q80 Is your elderly dependent planning to live in the home as long as he/she can?
- Yes (1)
- No (2)
- Don't know (3)

Q81 Elderly Dependent: Still Working?

Q82 Is your elderly dependent still participating in workforce?
- Full time (1)
- Part time (2)
- Retired (3)
- Other (4) _____

Answer If Is your elderly dependent still participating in workforce? Full time Is Selected Or Is your elderly dependent still participating in workforce? Part time Is Selected

Q83 Do you know when your elderly dependent is planning to retire?
- Yes, in less than 5 years. (1)
- Yes, in 5 - 10 years. (2)
- Yes, over 10 years. (3)
- No, I don't know. (4)

Q84 Elderly Dependent: Still Driving?

Q85 Does your elderly dependent still drive?
- Yes, he/she still drives regularly. (1)
- Yes, but he/she only drives very occasionally. (3)
- No. (2)

Answer If Does your elderly dependent still drive? No. Is Not Selected

Q81 Do you know when your elderly dependent is planning to cease driving?
- Yes, in less than 5 years. (1)
- Yes, in 5 - 10 years. (2)
- Yes, over 10 years. (3)
- No, I don't know. (4)

Answer If Is your elderly dependent still a driver? No Is Selected

Q87 Has your elderly dependent ever had a driver license before?
- Yes (1)
- No (2)

Q89 Elderly Dependent: Transportation Reality

Q172 What travel options has your elderly dependent used in the past year? (check all options that apply)

- ❑ Walk (1)
- ❑ By bike (2)
- ❑ By private car - as a driver (3)
- ❑ By private car - as a passenger (4)
- ❑ By public transit - train (5)
- ❑ By public transit - bus (6)
- ❑ By public transit - paratransit/demand response services (7)
- ❑ By traditional taxi services (8)
- ❑ By new "taxi" services (e.g., Uber, Lyft, Sidecar) (9)
- ❑ Other (10) _____

Q92 Elderly Dependent: Transportation Reality

Q90 On average, how often does your elderly dependent go out for dining, shopping, health care, recreation, or social events?

- ❍ More than twice everyday (1)
- ❍ Once or twice everyday (2)
- ❍ 3-5 times every week (3)
- ❍ Once or twice every week (4)
- ❍ Less than once every week (5)

Q91 On average, how long do these trips take him/her to travel one way?

- ❍ Less than 10 minutes (1)
- ❍ 10-30 minutes (2)
- ❍ More than 30 minutes (3)

Q93 When your elderly dependent goes out for these trips, what travel option does he/she use the most?

- ❍ Walk (1)
- ❍ By bike (2)
- ❍ By private car - as a driver (3)
- ❍ By private car - as a passenger (4)
- ❍ By public transit - train (5)
- ❍ By public transit - bus (6)
- ❍ By public transit - paratransit/demand response services (7)
- ❍ By traditional taxi services (8)
- ❍ By new "taxi" services (e.g., Uber, Lyft, Sidecar) (9)
- ❍ Other (10) _____

Q94 In my opinion, my elderly dependent picks the above mentioned travel option because he/she doesn't have other feasible transportation options.

- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Somewhat Disagree (3)
- ❍ Neither Agree nor Disagree (4)
- ❍ Somewhat Agree (5)
- ❍ Agree (6)
- ❍ Strongly Agree (7)

Q95 In my opinion, my elderly dependent picks the above mentioned travel option because it's more convenient.
- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

Q96 In my opinion, my elderly dependent picks the above mentioned travel option because of his/her own preference.
- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

Q97 In my opinion, my elderly dependent picks the above mentioned travel option because it helps him/her to maintain independence.
- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

Q98 In my opinion, my elderly dependent picks the above mentioned travel option because his/her friends and neighbors use the same option for travel as well.
- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

Q99 In my opinion, my elderly dependent picks the above mentioned travel option because it's less expensive.
- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

Q100 Please list other factors that may affect your elderly dependent's travel mode choices:

Q98 Elderly Dependent: Transportation Reality

Q101 Has your elderly dependent used any home delivery service (e.g., from a local grocery/drug store or online shopping)?

- ❑ Yes, he/she has ordered delivery services. (1)
- ❑ Yes, I've ordered delivery services for him/her. (2)
- ❑ No. (3)

If No. Is Selected, Then Skip To End of Block

Q102 How do you/your elderly dependent order your delivery services? (check all options that apply)

- ❑ Home phone (1)
- ❑ Cell phone (2)
- ❑ Internet (3)
- ❑ Other (4) _____

Q103 How often do you/your elderly dependent use delivery services?

- ❍ Every week (1)
- ❍ Every other week (2)
- ❍ Every month (3)
- ❍ Occasionally (4)

Q104 Have these deliveries changed or substituted your elderly dependent's own travel?

- ❍ Yes, he/she makes fewer total trips. (1)
- ❍ Yes, he/she makes fewer shopping trips but about the same number of total trips. (2)
- ❍ No, he/she makes same number of trips as before. (3)

Q107 Elderly Dependent: Preferences on Transportation Options

Q108 In my opinion, if my elderly dependent ever need any help on transportation access, he/she prefers supports from neighbors/community centers (e.g., local YMCA/senior center shuttle services).

- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Somewhat Disagree (3)
- ❍ Neither Agree nor Disagree (4)
- ❍ Somewhat Agree (5)
- ❍ Agree (6)
- ❍ Strongly Agree (7)

Q109 In my opinion, if my elderly dependent ever need any help on transportation access, he/she prefers supports from public agencies (e.g., local transit agency).

- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Somewhat Disagree (3)
- ❍ Neither Agree nor Disagree (4)
- ❍ Somewhat Agree (5)
- ❍ Agree (6)
- ❍ Strongly Agree (7)

Q110 In my opinion, if my elderly dependent ever need any help on transportation access, he/she prefers supports from private services (e.g., taxi or Uber services).

- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Somewhat Disagree (3)
- ❍ Neither Agree nor Disagree (4)
- ❍ Somewhat Agree (5)
- ❍ Agree (6)
- ❍ Strongly Agree (7)

Q111 In my opinion, if my elderly dependent ever need any help on transportation access, he/she prefers supports from family members/friends.

- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Somewhat Disagree (3)
- ❍ Neither Agree nor Disagree (4)
- ❍ Somewhat Agree (5)
- ❍ Agree (6)
- ❍ Strongly Agree (7)

Q176 In my opinion, if better transportation services are provided, my elderly dependent would like to go out more often for dining, shopping, health care, recreation, or social events.

- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Somewhat Disagree (3)
- ❍ Neither Agree nor Disagree (4)
- ❍ Somewhat Agree (5)
- ❍ Agree (6)
- ❍ Strongly Agree (7)

Q112 In your opinion, has your elderly dependent worried about his/her transportation options before?

- ❍ No. (1)
- ❍ Yes, less than 5 years ago. (2)
- ❍ Yes, 5-10 years ago. (3)
- ❍ Yes, over 10 years ago. (4)

Q108 Have you worried about your elderly dependent's transportation options before?

- ❍ No. (1)
- ❍ Yes, less than 5 years ago. (2)
- ❍ Yes, 5-10 years ago. (3)
- ❍ Yes, over 10 years ago. (4)

Q113 Any additional comments on this topic of senior transportation options?

Q117 Elderly Dependent: Attitudes towards New Transportation Options

Q118 In my opinion, if neighbors/community centers inform my elderly dependent about NEW transportation options (e.g., new shuttle services provided by local senior center, new bus lines provided by public transit agency, or new private services specialized for seniors), he/she would like to try/use them.

- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Somewhat Disagree (3)
- ❍ Neither Agree nor Disagree (4)
- ❍ Somewhat Agree (5)
- ❍ Agree (6)
- ❍ Strongly Agree (7)

Q119 In my opinion, if public agencies inform my elderly dependent about NEW transportation options (e.g., new shuttle services provided by local senior center, new bus lines provided by public transit agency, or new private services specialized for seniors), he/she would like to try/use them.

- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Somewhat Disagree (3)
- ❍ Neither Agree nor Disagree (4)
- ❍ Somewhat Agree (5)
- ❍ Agree (6)
- ❍ Strongly Agree (7)

Q120 In my opinion, if private companies/commercial advertisements inform my elderly dependent about NEW transportation options (e.g., new shuttle services provided by local senior center, new bus lines provided by public transit agency, or new private services specialized for seniors), he/she would like to try/use them.

- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Somewhat Disagree (3)
- ❍ Neither Agree nor Disagree (4)
- ❍ Somewhat Agree (5)
- ❍ Agree (6)
- ❍ Strongly Agree (7)

Q121 In my opinion, if family members/friends inform my elderly dependent about NEW transportation options (e.g., new shuttle services provided by local senior center, new bus lines provided by public transit agency, or new private services specialized for seniors), he/she would like to try/use them.

- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Somewhat Disagree (3)
- ❍ Neither Agree nor Disagree (4)
- ❍ Somewhat Agree (5)
- ❍ Agree (6)
- ❍ Strongly Agree (7)

Q122 Elderly Dependent: Perceived Health Status

Q123 In my opinion, my elderly dependent's health is very good.
- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Somewhat Disagree (3)
- ❍ Neither Agree nor Disagree (4)
- ❍ Somewhat Agree (5)
- ❍ Agree (6)
- ❍ Strongly Agree (7)

Q124 What health insurance plans does your elderly dependent have?
- ❑ Medicare (1)
- ❑ Medicaid (2)
- ❑ Commercial/private insurance (3)
- ❑ Self-pay (4)
- ❑ Other (5) _____

Q125 Current transportation options have become barriers for my elderly dependent's visits to doctor or medical treatment.
- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Somewhat Disagree (3)
- ❍ Neither Agree nor Disagree (4)
- ❍ Somewhat Agree (5)
- ❍ Agree (6)
- ❍ Strongly Agree (7)

Q54 Demographics

Q55 What is your sex?
- ❍ Male (1)
- ❍ Female (2)

Q56 Which best describes your race?
- ❑ White (1)
- ❑ African American (2)
- ❑ Hispanic (3)
- ❑ Asian or Pacific Islander (4)
- ❑ Native American (5)
- ❑ Other (6) _____

Q57 What's your total household income?
- Less than 10,000 (1)
- 10,000 - 19,999 (2)
- 20,000 - 29,999 (3)
- 30,000 - 39,999 (4)
- 40,000 - 49,999 (5)
- 50,000 - 59,999 (6)
- 60,000 - 69,999 (7)
- 70,000 - 79,999 (8)
- 80,000 - 89,999 (9)
- 90,000 - 99,999 (10)
- 100,000 - 149,999 (11)
- More than 150,000 (12)
- I prefer not to answer (13)

Q58 What is the highest grade or year of school you have completed?
- Less Than High School Graduate (1)
- High School Graduate or GED (2)
- Some College or Associate's Degree (3)
- Bachelor's Degree (4)
- Post Graduate Degree (Master's, PhD, MD, JD etc) (5)
- Other (6) _____

(For Type 3 Survey Respondents: Youngers – who answered in Q3 that they are younger than 65 years and in Q60 that they are not caregivers of an elderly dependent or in Q61 that their elderly dependent lives in an institutional care facility)

Q59 Caregiver?

Q60 Are you a caregiver of an elderly dependent who is 65 years old and over?
- Yes (1)
- No (2)

Answer If Are you a caregiver of an elderly dependent? Yes Is Selected

Q61 Does your elderly dependent live in an institutional care facility (e.g., nursing home)?
- Yes (1)
- No (2)

Q131 Living Environment

Q132 Which best describes the place you live?
- Urban area (1)
- Suburban area (2)
- Rural area (3)

Q133 Approximately, how far is your home away from shopping areas (e.g., restaurants, grocery stores, pharmacies)?
- Less than 1/2 mile (i.e., within walking distance) (1)
- 1/2 - 5 miles (2)
- 5 - 10 miles (3)
- Greater than 10 miles (4)

Q134 Approximately, how far is your home away from healthcare facilities (e.g., doctor offices, hospitals)?
- Less than 1/2 mile (i.e., within walking distance) (1)
- 1/2 - 5 miles (2)
- 5 - 10 miles (3)
- Greater than 10 miles (4)

Q135 Approximately, how far is your home away from recreational areas or social places (e.g., parks, YMCAs, community centers)?
- Less than 1/2 mile (i.e., within walking distance) (1)
- 1/2 - 5 miles (2)
- 5 - 10 miles (3)
- Greater than 10 miles (4)

Q136 What is the ZIP Code for where your home is located?

Q168 Is your home a house, an apartment, or some other type of residence?
- House (1)
- Apartment (2)
- Other (3) _____

Q137 Is your home owned or rented?
- Owned (1)
- Rented (2)
- Other (3) _____

Q138 Including yourself, how many people live in your household?
- 1 (1)
- 2 (2)
- 3 (3)
- 4 (4)
- 5 (5)
- More Than 5 (7)

Answer If Including yourself, how many people live in your household? 1 Is Not Selected

Q178 How many household members are 65 years old and over?
- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- More Than 4 (6)

Q139 Are you planning to live in the home as long as you can?
- ❍ Yes (1)
- ❍ No (2)
- ❍ Not sure as of now (3)

Q140 Working?

Q141 Are you participating in workforce?
- ❍ Full time (1)
- ❍ Part time (2)
- ❍ No (4)
- ❍ Other (3) _____

Answer If Are you participating in workforce? Full time Is Selected Or Are you participating in workforce? Part time Is Selected

Q142 When are you planning to retire?
- ❍ Less than 55 (1)
- ❍ 55 - 64 (2)
- ❍ 65 - 74 (3)
- ❍ 75 - 84 (4)
- ❍ 85 + (5)
- ❍ Not sure as of now (6)

Q143 Driving?

Q144 Do you drive?
- ❍ Yes, I drive regularly. (1)
- ❍ Yes, but I only drive very occasionally. (3)
- ❍ No. (2)

Answer If Do you drive? No. Is Not Selected

Q137 When are you planning to cease driving?
- ❍ Less than 55 (1)
- ❍ 55 - 64 (2)
- ❍ 65 - 74 (3)
- ❍ 75 - 84 (4)
- ❍ 85 + (5)
- ❍ Not sure as of now (6)

Answer If Are you a driver? No Is Selected

Q146 Have you ever had a diver license before?
- ❍ Yes (1)
- ❍ No (2)

Q148 Transportation Reality

Q171 What travel options have you used in the past year? (check all options that apply to you)
- ❑ Walk (1)
- ❑ By bike (2)
- ❑ By private car - as a driver (3)
- ❑ By private car - as a passenger (4)
- ❑ By public transit - train (5)
- ❑ By public transit - bus (6)
- ❑ By public transit - paratransit/demand response services (7)
- ❑ By traditional taxi services (8)
- ❑ By new "taxi" services (e.g., Uber, Lyft, Sidecar) (9)
- ❑ Other (10) _____

Q151 Transportation Reality

Q149 On average, how often do you go out for dining, shopping, health care, recreation, or social events?
- ❍ More than twice everyday (1)
- ❍ Once or twice everyday (2)
- ❍ 3-5 times every week (3)
- ❍ Once or twice every week (4)
- ❍ Less than once every week (5)

Q150 On average, how long do these trips take you to travel one way?
- ❍ Less than 10 minutes (1)
- ❍ 10-30 minutes (2)
- ❍ More than 30 minutes (3)

Q152 When you go out for these trips, what travel option do you use the most?
- ❍ Walk (1)
- ❍ By bike (2)
- ❍ By private car - as a driver (3)
- ❍ By private car - as a passenger (4)
- ❍ By public transit - train (5)
- ❍ By public transit - bus (6)
- ❍ By public transit - paratransit/demand response services (7)
- ❍ By traditional taxi services (8)
- ❍ By new "taxi" services (e.g., Uber, Lyft, Sidecar) (9)
- ❍ Other (10) _____

Q153 I pick the above mentioned travel option because I don't have other feasible transportation options.
- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Somewhat Disagree (3)
- ❍ Neither Agree nor Disagree (4)
- ❍ Somewhat Agree (5)
- ❍ Agree (6)
- ❍ Strongly Agree (7)

Q154 I pick the above mentioned travel option because it's more convenient.
- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

Q155 I pick the above mentioned travel option because of my own preference.
- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

Q156 I pick the above mentioned travel option because it helps me to maintain independence.
- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

Q157 I pick the above mentioned travel option because my friends and neighbors use the same option for travel as well.
- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

Q158 I pick the above mentioned travel option because it's less expensive.
- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

Q159 Please list other factors that may affect your travel mode choices:

Q149 Thinking about the future when I become old, I will continue to use the above mentioned travel option as long as I can.

- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Somewhat Disagree (3)
- ❍ Neither Agree nor Disagree (4)
- ❍ Somewhat Agree (5)
- ❍ Agree (6)
- ❍ Strongly Agree (7)

Q161 Transportation Reality

Q162 Have you used any home delivery service (e.g., from a local grocery/drug store or online shopping)?

- ❍ Yes (1)
- ❍ No (2)

If No Is Selected, Then Skip To End of Block

Q163 How do you order your delivery services? (check all options that apply to you)

- ❑ Home phone (1)
- ❑ Cell phone (2)
- ❑ Internet (3)
- ❑ Other (4) _____

Q164 How often do you use delivery services?

- ❍ Every week (1)
- ❍ Every other week (2)
- ❍ Every month (3)
- ❍ Occasionally (4)

Q165 Have these deliveries changed or substituted your own travel?

- ❍ Yes, I make fewer total trips myself. (1)
- ❍ Yes, I make fewer shopping trips but about the same number of total trips. (2)
- ❍ No, I make same number of trips as before. (3)

Q166 Thinking about the Future: Preferences on Transportation Options

Q167 If I ever need any help on transportation access, I prefer supports from neighbors/community centers (e.g., local YMCA/senior center shuttle services).

- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Somewhat Disagree (3)
- ❍ Neither Agree nor Disagree (4)
- ❍ Somewhat Agree (5)
- ❍ Agree (6)
- ❍ Strongly Agree (7)

Q168 If I ever need any help on transportation access, I prefer supports from public agencies (e.g., local transit agency).
- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Somewhat Disagree (3)
- ❍ Neither Agree nor Disagree (4)
- ❍ Somewhat Agree (5)
- ❍ Agree (6)
- ❍ Strongly Agree (7)

Q169 If I ever need any help on transportation access, I prefer supports from private services (e.g., taxi or Uber services).
- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Somewhat Disagree (3)
- ❍ Neither Agree nor Disagree (4)
- ❍ Somewhat Agree (5)
- ❍ Agree (6)
- ❍ Strongly Agree (7)

Q170 If I ever need any help on transportation access, I prefer supports from family members/friends.
- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Somewhat Disagree (3)
- ❍ Neither Agree nor Disagree (4)
- ❍ Somewhat Agree (5)
- ❍ Agree (6)
- ❍ Strongly Agree (7)

Q175 If better transportation services are provided, I'd like to go out more often for dining, shopping, health care, recreation, or social events.
- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Somewhat Disagree (3)
- ❍ Neither Agree nor Disagree (4)
- ❍ Somewhat Agree (5)
- ❍ Agree (6)
- ❍ Strongly Agree (7)

Q172 Any additional comments on this topic of senior transportation options?

Q173 Thinking about the Future: Attitudes towards New Transportation Options

Q174 When I become old, if neighbors/community centers inform me about NEW transportation options (e.g., new shuttle services provided by local senior center, new bus lines provided by public transit agency, or new private services specialized for seniors), I'd like to try/use them.

- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Somewhat Disagree (3)
- ❍ Neither Agree nor Disagree (4)
- ❍ Somewhat Agree (5)
- ❍ Agree (6)
- ❍ Strongly Agree (7)

Q175 When I become old, if public agencies inform me about NEW transportation options (e.g., new shuttle services provided by local senior center, new bus lines provided by public transit agency, or new private services specialized for seniors), I'd like to try/use them.

- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Somewhat Disagree (3)
- ❍ Neither Agree nor Disagree (4)
- ❍ Somewhat Agree (5)
- ❍ Agree (6)
- ❍ Strongly Agree (7)

Q176 When I become old, if private companies/commercial advertisements inform me about NEW transportation options (e.g., new shuttle services provided by local senior center, new bus lines provided by public transit agency, or new private services specialized for seniors), I'd like to try/use them.

- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Somewhat Disagree (3)
- ❍ Neither Agree nor Disagree (4)
- ❍ Somewhat Agree (5)
- ❍ Agree (6)
- ❍ Strongly Agree (7)

Q177 When I become old, if family members/friends inform me about NEW transportation options (e.g., new shuttle services provided by local senior center, new bus lines provided by public transit agency, or new private services specialized for seniors), I'd like to try/use them.

- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Somewhat Disagree (3)
- ❍ Neither Agree nor Disagree (4)
- ❍ Somewhat Agree (5)
- ❍ Agree (6)
- ❍ Strongly Agree (7)

Q178 Perceived Health Status

Q179 In general, my health is very good.
- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Somewhat Disagree (3)
- ❍ Neither Agree nor Disagree (4)
- ❍ Somewhat Agree (5)
- ❍ Agree (6)
- ❍ Strongly Agree (7)

Q180 What health insurance plans do you have?
- ❑ Commercial/private insurance (1)
- ❑ Medicaid (2)
- ❑ Self-pay (3)
- ❑ Other (4) _____

Q181 My current transportation options have become barriers for my visits to doctor or medical treatment.
- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Somewhat Disagree (3)
- ❍ Neither Agree nor Disagree (4)
- ❍ Somewhat Agree (5)
- ❍ Agree (6)
- ❍ Strongly Agree (7)

Q171 When I get old, transportation options could become barriers for my visits to doctor or medical treatment.
- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Somewhat Disagree (3)
- ❍ Neither Agree nor Disagree (4)
- ❍ Somewhat Agree (5)
- ❍ Agree (6)
- ❍ Strongly Agree (7)

Q54 Demographics

Q55 What is your sex?
- ❍ Male (1)
- ❍ Female (2)

Q56 Which best describes your race?
- ❑ White (1)
- ❑ African American (2)
- ❑ Hispanic (3)
- ❑ Asian or Pacific Islander (4)
- ❑ Native American (5)
- ❑ Other (6) _____

Q57 What's your total household income?

- ❍ Less than 10,000 (1)
- ❍ 10,000 - 19,999 (2)
- ❍ 20,000 - 29,999 (3)
- ❍ 30,000 - 39,999 (4)
- ❍ 40,000 - 49,999 (5)
- ❍ 50,000 - 59,999 (6)
- ❍ 60,000 - 69,999 (7)
- ❍ 70,000 - 79,999 (8)
- ❍ 80,000 - 89,999 (9)
- ❍ 90,000 - 99,999 (10)
- ❍ 100,000 - 149,999 (11)
- ❍ More than 150,000 (12)
- ❍ I prefer not to answer (13)

Q58 What is the highest grade or year of school you have completed?

- ❍ Less Than High School Graduate (1)
- ❍ High School Graduate or GED (2)
- ❍ Some College or Associate's Degree (3)
- ❍ Bachelor's Degree (4)
- ❍ Post Graduate Degree (Master's, PhD, MD, JD etc) (5)
- ❍ Other (6) _____